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Do What You Like

The secret of happiness is not in doing what one likes, but in liking what one does.

I HAVE tried to express this idea upon this page several times, but have not done so with the aptness of the unknown writer of the quotation above.

If one likes what one is doing, one will make a success of it in spite of handicaps and personal limitations.

When a man does a thing for the love of it, he does it better. He sees new ways of doing it, new touches to put upon it, new developments of it that would never occur to the drudge who plodded through it with his eyes on the clock and his mind on his luncheon or his girl.

Of course, when one does what one likes, one likes what one does— but there is a difference.

If a person is going to pay his way in the world, to render that service which is the rent that he pays for the place that he occupies in the social order, if he is going to make the corner where he is brighter while he lives and better for his having lived in it, he must serve in some way or produce something useful.

It is the one who likes to do something of this kind who gets on.

And a liking for such things can be cultivated or discovered.

For the man who has been brought up in idleness or tied down to drudgery there are paths open through which he could find useful application of his talents and abilities and realize the joys and accomplishment and the emoluments of success.

It calls for initiative and the enterprise and daring to break out of the beaten path on the part of the drudge and for concentration, application and restraint on the part of the idler.

The atoms of carbon that flit aimlessly through the atmosphere become useful and valuable when, by a satisfied affinity, they are restrained in the growing vegetable structure or the sparkling crystal of the diamond.

F. R. Low

Waukegan Places 50,000-Kw. Turbine Unit in Service

AT THE Waukegan plant of the Public Service Company of Northern Illinois the third unit, a steam turbine-generator of 50,000-kw. capacity, has been placed in service. The first two units (*Power*, page 80, Jan. 15, 1924) were rated at 25,000 and 35,000 kw. respectively. Steam is furnished to each of these units at 400 lb. pressure. Three-phase 60-cycle current is generated at 12,000 volts and distributed at 12, 33 and 132 kv. The electric-driven auxiliaries for these units are supplied with 480 volts obtained from suitable step-down transformers. While following the lines of the previous installations in general, the new unit installation presents a number of interesting developments, such as the use of steam at 600 lb. pressure, preheated air for combustion, a closed system of ventilation for the generator with the air circulation produced by independent motor-driven fans, the use of 2,300-volt motor-driven auxiliaries starting on full voltage, metal-clad switch-gear and busbars for all potentials and armored cables for the auxiliary services.

NEW unit uses steam at 600 lb. pressure and 725 deg. F. superheat and is bled at four points to heat the feed water. Economizer and air preheaters are used. Air temperature is raised to 350-deg. F. for use under chain grates. Electrical features are two-motor drive of induced-draft fans, two-speed vertical motors for circulating pumps, full-voltage starting of the 2300-volt auxiliary motors, metal-clad switchgear, busbars for all potentials and armored cables for all auxiliary services. The main 12,000-volt Reyrolle switches are reported to be the largest of their kind in the world.

The new generating unit (*Power*, page 942, Dec. 21, 1926) consists of a reaction-type two-cylinder tandem-compound steam turbine, connected to a single generator, with direct-connected exciter. It is rated at 50,000 kw. at 85 per cent power factor and runs at a speed of 1,800 r.p.m. The turbine is designed to operate at a steam pressure of 600 lb., a superheat of 725 deg. F. and a vacuum of 29 in. of mercury. The turbine is served by a 57,000-sq.ft. surface condenser. Circulating water is provided by two vertical-shaft centrifugal pumps, set below the water level and direct connected to two-speed squirrel-cage induction motors. At the high speed of 250 r.p.m. the combined capacity of these pumps is 70,000 gal. per min. The air circulation for the ventilation of the generator is produced by two fans direct-connected to induction motors, their combined capacity being 160,000 cu.ft. of air per minute. Cooling of the air is effected by an air cooler in the discharge duct between the generator and the fans.

To supply the new turbine with steam, four cross-drum water-tube boilers have been installed, each having two decks of tubes of 14,369 s.ft. and 715 sq.ft. of cooling surface in the furnace. Plain tubes spaced on 9-in. centers and covered with C-tile are used on the side and rear walls. At the front wall the cooling tubes are used to support the ignition arch. Each boiler has capacity to evaporate 200,000 lb. of water per hour from the temperature of the feed to a steam pressure of 635 lb. gage.

The auxiliary equipment consists of a convection superheater between the first and second deck of tubes, a forced-draft chain grate with 467 sq.ft. effective area, a steel-tube economizer with 7,053 sq.ft. of surface, and immediately following two air preheater units of the rotary type with 80,000 sq.ft. of surface, one-half of which is effective at any one time. These preheaters supply air to the stoker at approximately 350 deg. F. Each boiler has two forced-draft and one induced-draft fan. The former is integral with the air preheater units and driven by the same motors that rotate the preheating elements through chain drives. To improve flexibility and economy, the induced-draft fan is driven by two motors, one arranged to provide a range of speed from 230 to 490 r.p.m. and the other to provide a range from 490 to 700 r.p.m. All the fan motors are of the slip-ring wound-rotor type with external secondary resistances.

Among the other auxiliary equipment mention may be made of the boiler feed pumps, of which there are three, two being direct-connected to 600-hp. 1,800-r.p.m. squirrel-cage motors and the other to a steam turbine. Starting of the motors is effected through reactors that are automatically short-circuited through appropriate switches when the starting current has fallen to a predetermined value. The auxiliary motor control system has been developed to reduce the possibility of human error in the operation. Provisions have been made to transfer the induced-draft fan load automatically from one motor to the other and for changing the speeds of the two-speed circulating water pump motors. Alternating current is used exclusively for the motor-driven auxiliary equipment. All motors rated 50 hp. and above are designed for 2,300-volt operation, whereas the smaller ones operate at 440 volts. All the motors are of the squirrel-cage type with the exception of the draft-fan motors, which have secondary resistance starting, and the stoker motors, which are variable-speed, brush-shifting alternating-current machines. The only motors that are

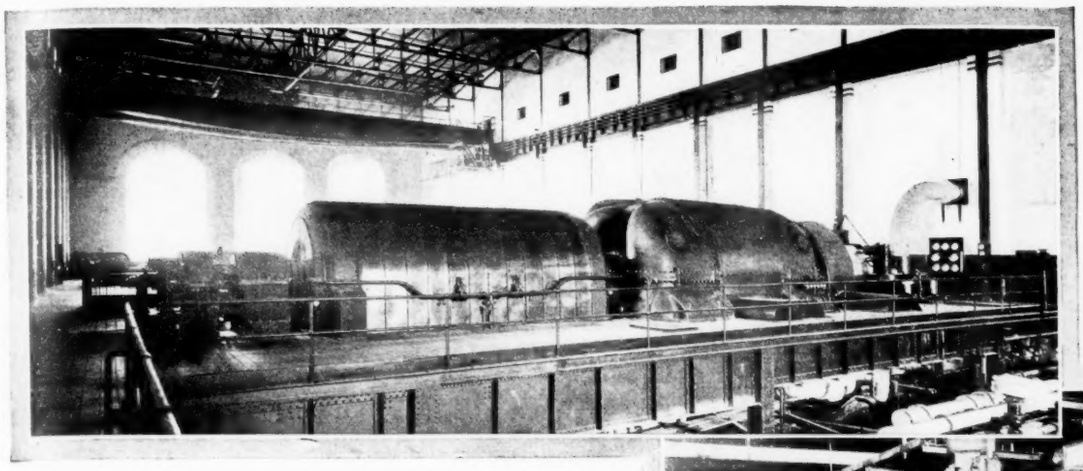


Fig. 1 (Above)—New generating unit consists of a two-cylinder tandem compound turbine connected to a 50,000-kw. generator

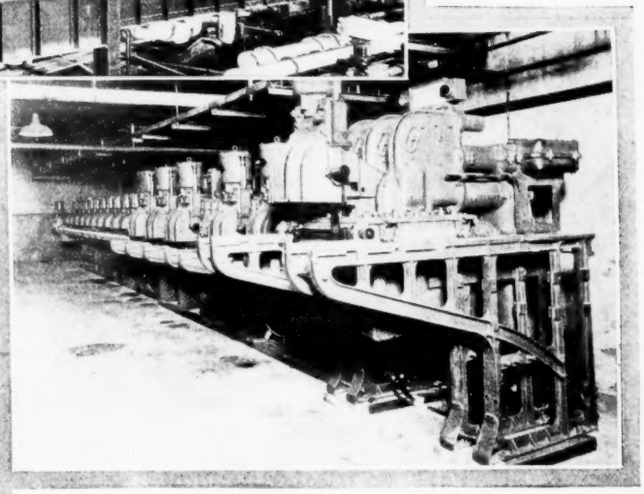


Fig. 2 (Above)—Well-constructed, neatly arranged 2,400-volt auxiliary switching equipment

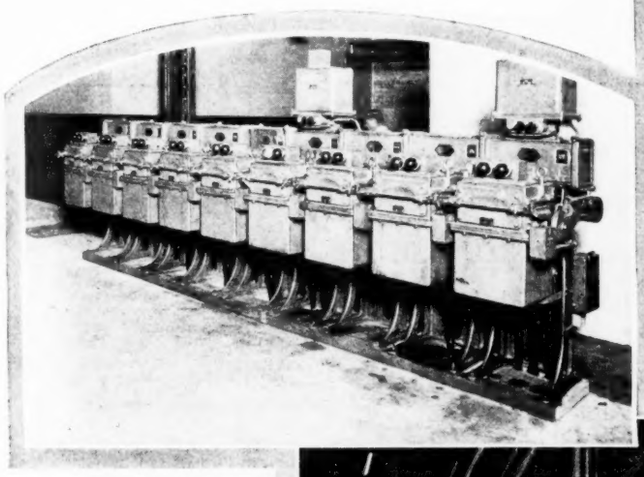


Fig. 3 (Above)—Compact and sturdy 440-volt auxiliary switching equipment

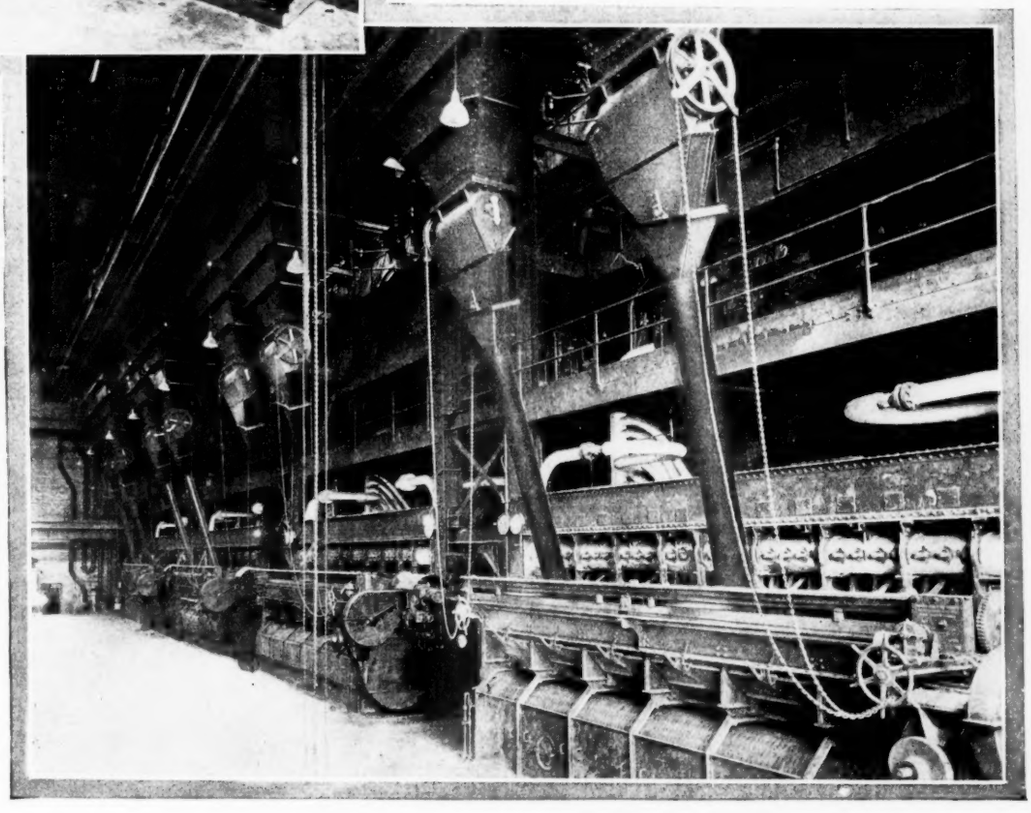


Fig. 4 (Right)—Four cross-drum water-tube boilers with 15,084 sq.ft. of heating surface installed to serve the turbine

not started at full voltage are those driving the boiler feed pumps. The largest of the motors at full voltage are the 275-hp., 250-r.p.m. circulating water pump motors, and, of the high-speed motors, the 150-hp., 1,760-r.p.m. generator air fan motors. Service for the auxiliary motor equipment is obtained from step-down transformers.

Reference to Fig. 6, a heat balance diagram with full load on the turbine, will show that steam is bled at four points to heat the feed water. Three closed extraction heaters and an open heater in conjunction with a deaërator are used. The path of the condensate is made evident, except that the generator air cooler is the first piece of equipment from which heat is absorbed. Pressures, temperatures and B.t.u. content are given throughout. Heater No. 1, the deaërator condenser, heater No. 2, the open heater and the deaërator, express the order of flow. From the deaërator the feed pumps draw their supply and force it through heater No. 3 and the economizer to the boiler. When operating at full load, the water reaches a temperature approximating 375 deg., the economizer being responsible for the final 110 deg.

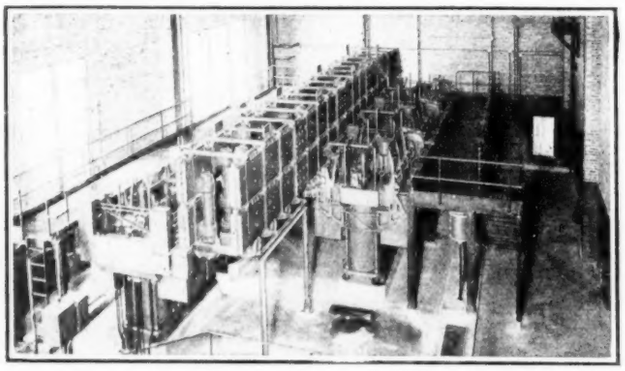


Fig. 5—Main 12,000-volt switching structure containing seven units of metal-clad switch gear

It will be seen that the open heater gets its steam from the exhaust header at 25 lb. abs. One boiler-feed and one service pump are turbine driven and operate against this back pressure, but as operation of the motor-driven pumps is standard practice, steam may be drawn from the third bleeding point on the turbine. The pressure here is 41 lb. abs., so the supply must pass through a reducing valve. Steam from this same header also heats the building.

Through float valves, condensation from the extraction heaters drains back in each case to the preceding heater. From No. 1 heater the condensation is pumped back into the line, but if the pump should fail, it drains back to the condenser.

In lieu of an evaporator all clean drips, drains and overflows are collected in a storage reservoir, and to this supply is added "permutized" and acid-treated water. This is the makeup supply which, under float control, is pumped to the open heater.

In the electrical end of the plant the main, or 12,000-volt, switching structure, Fig. 5, is out of the ordinary in American practice. Seven panels or units of Reyrolle, metal-clad switch-gear with double deck, twin (main and reserve) metal-clad busbars constitute the present installation. This is the first installation of this particular type of switch gear in a generating station in the United States, and it is said that the main switches are the largest of their kind in the world.

The switch panels or units are arranged in two parallel rows with the busbars in parallel rows above, but between, the switch rows. Though a reserve busbar is provided, largely as a means of connection between the switch structures previously installed and those it is anticipated to install in the future, the switch gear provides but one switch on each circuit. Excepting, of course, the bus sectionalizing switches, the switches are arranged for connection to either busbar by means of selector disconnecting switches.

For the main services the switch panels are rated at 3,000 amperes, 12,000 volts, with an interrupting capacity of 1,500,000 kva. The switch panels for the auxiliary transformer circuits, rated at 600 amperes capacity, differ from the larger switches only in the sizes of the current conductors and contact surfaces. Each switch panel with its complement of the busbars weighs about 24 tons and occupies a space approximately 12 by 14 ft. and 14 ft. high.

Each switch panel is a complete unit from the busbars to the connecting cables, with all live parts metal-clad. The busbars disconnecting switches, main and arcing contacts, cable disconnecting and grounding switches, and the current and potential transformers are immersed in oil. The busbars and the fixed conductors in the switch panel are buried in insulating compound. Complete separation of the phases is maintained throughout the whole equipment. At all points adjacent phases are separated by portions of the grounded metal inclosing structure.

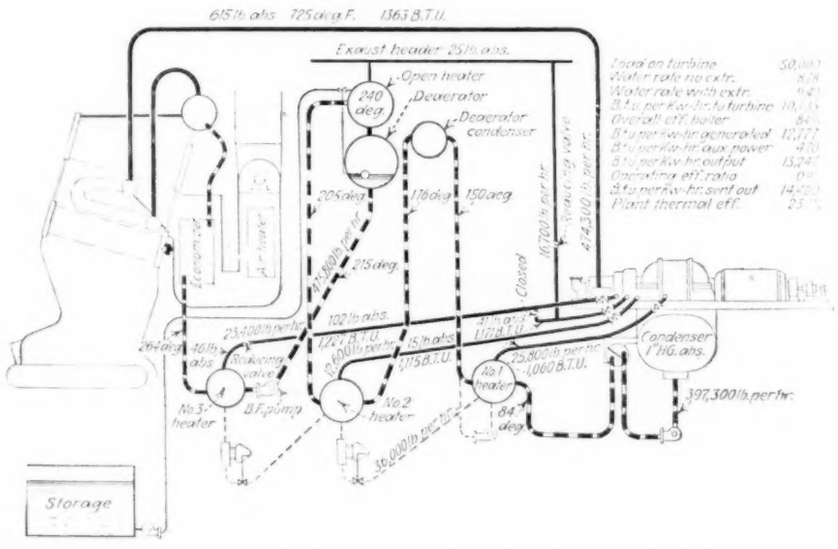


Fig. 6—Heat balance diagram with full load on the turbine

In general a switch panel may be described as consisting of three main single-phase switch tanks, resting on a common bedplate, surmounted by a common top plate, with disconnecting switch tanks on both sides of the main tanks and with the necessary trunks for the con-

nections to the busbars on one side and to the outgoing or incoming cables on the other side.

Each switch panel is mechanically interlocked so that all the operations of the disconnecting and grounding switches can be made only in established sequence, and so that no live parts may be exposed at any time. The group of switch panels are also electrically interlocked so that no busbar connections at the selector disconnecting switches may be exposed while the corresponding busbar is alive. The switch panels are also interlocked with the traveling crane so that hoisting operations can be performed only when the crane hook is immediately over the particular panel involved and then only provided the main switch and all the necessary disconnecting switches are open.

The 2,400-volt and 480-volt auxiliary switching structures, Figs. 2 and 3, are almost as unusual as the main switching structure, being made up of switch panels of substantially similar characteristics but of different types. These switch panels are of the horizontal draw-out type with air break, plug and receptacle disconnecting switches. When the switches are drawn out, automatically operated doors effectively prevent access to the busbar disconnecting switch receptacles.

While it might appear that such an installation would be rather expensive owing to the fact that the cost is higher than that of comparable equipment of the usual type, a considerable saving is effected in other phases of the installation, owing to the elimination of switch cells, simplification of building requirements and simplicity of installation. The safety and reliability features are of course paramount.

Waste Heat From Diesel Engines

THE recovery of waste heat from Diesel engines is a problem that has had attention directed at it from the beginning of Diesel-engine history, but it is only during the last few years that the question has been considered from a rational point of view.

Where the hot cooling water from the Diesel engine cannot be used direct for baths, process work, washing or similar applications, it is easy to use it for heating purposes, and a hot-water heating system is the more advantageous, as in this case most of the heat is made available.

The total waste heat that can be utilized in this way represents about 45 per cent, or around 8,100 B.t.u. for each pound of fuel consumed.

The return from the heating elements or radiators is pumped through the cylinders, jackets and cylinder heads by means of a small motor-driven centrifugal pump and is further heated in an exhaust-gas boiler. The motor-driven centrifugal pump will be necessary to obtain a good circulation of the water, and smaller pipe sizes can be used than with natural circulation.

If held within reasonable limits in ordinary practice, no measurable increase in fuel-oil consumption will be incurred and the back pressure will be appreciable only when the engine is overloaded. In such cases it might be best to bypass the exhaust around the boiler as long as the overload prevails. The diameter of the waste-heat boiler tubes must not be made too large, as the gases otherwise will be moving with great velocity in the middle or coro-area of the tubes and with only a comparatively small velocity along the walls. Furthermore, the tubes must be so arranged that they can easily be cleaned.

What Do You Know?

The answers are on page 396

SOMETIMES questions are too easy and our ability to answer them gives us a feeling of smug complacency by no means justified by the amount of information we actually possess. So the editor has worked up the ten questions below, which he warns you in advance are not too easy of solution. Compare your findings with the answers. If the editor seems to have gone astray in his answers, by all means tell him so. Your corrections will be paid for if they are correct and published.

Ques. 1—The automobile windshield wiper of the pneumatic type is driven indirectly by the engine. Where does this power show on the indicator diagram?

Ques. 2—The usual direct-current watt-hour meter is a motor with the armature connected across the line and the fields in series with the load. When the load current increases, the fields become stronger and the motor or meter runs faster. Why is this the case when strengthening the field of the usual direct-current power motor causes it to run slower?

Ques. 3—If the bell crank of the head-end exhaust-valve stem of the high-pressure cylinder of a cross-compound Corliss engine broke off, what would you do to prevent shutting down the plant until night?

Ques. 4—Suppose that the fuel tank of an air-injection Diesel engine was placed 5 ft. above the top of the engine and that the operator opened the valve to prime the fuel nozzle before he turned on the injection air. Further, assume that the air-line check valve was out of commission because a helper forgot to replace the ball check the last time he cleaned it. What would you expect to happen when the starting air was turned on and the engine turned over? Why? What would you do in such a case?

Ques. 5—Suppose in a plant using boiler oil it was found that the furnace walls vibrated violently, to what would you ascribe the trouble?

Ques. 6—Is it possible to cool water by using steam at a higher temperature? This does not refer to the usual refrigerating process.

Ques. 7—If it be true that the pressure exerted by a quantity of gas contained in a vessel is independent of the pressure exerted by a second gas contained in the vessel, and the total pressure will be the sum of the two gas pressures, will the total pressure in a vessel holding a charge of air and ammonia be equal to the sum of the ammonia vapor pressure and the pressure of the air?

Ques. 8—As the temperature is lowered, part of any water vapor in the air settles out as dew or water. If the temperature is dropped to 30 deg. F., will all the water vapor in a given volume settle out as water and freeze? Can air be dried in this way?

Ques. 9—In testing the fineness of pulverized coal, a 100-mesh sieve is used. What is the largest diameter particle that will go through this mesh?

Ques. 10—Steel wire has a breaking strain of 100,000 lb. per sq.in. and a mile of it with a cross-section of 1 sq.in. weighs 17,000 lb. In other words, the weight of less than 6 miles of steel wire hanging vertically is sufficient to break it. If this be true, how is it possible to have a steel cable that will handle a load out of a hole 8 miles deep. This depth is assumed for an example and no factor of safety is used in this question and answer.

Correcting Faults in the Heating-System Returns

By W. Edward

THIS is the third of a series of articles, started in the Aug. 30 issue of *Power*, that relate the troubles found in the heating system of an industrial plant. In this article the faults found in the heating-system returns are discussed.

"OVERHAULING the heating system is a simple matter," said our engineer friend, "provided—"

"Provided what?" we asked of this engineer whom we had secured as a representative from the field service department of a manufacturer of heating-system equipment.

"Provided you start at the right end first. Usually, you plant engineers have an idea that all you need is more equipment. I'll agree to that, for you usually do, but the time to consider new equipment is after you have corrected the faults in the system itself. Why, just the things we have mentioned so far—the choked low-pressure main, the lift in the return lines, the pockets under doorways—are enough to render traps and vacuum pumps nearly useless.

"The way to locate these points is first to make a complete pipe-line layout as you have done so easily by using the symbols I have given you. Now I want to get along with the lines this time so we can check up on equipment. From then on it will be up to you.

"By putting lift fittings in the return-main riser you can get the water back, but still you will not be able to hold a vacuum in the system."

"And what now?" we wanted to know.

"Those heater-blower units that you are operating at 75 lb. pressure are killing the vacuum just as long as they are running. Now let me do a little problem to prove my point.

"We will assume you want to maintain 8 in. of vacuum in the return lines when everything is working. From the steam tables we find temperature of vaporization at 8 in., vacuum 197 deg. F., temperature of vaporization at 75 lb. gage 320 deg. F. If water hotter than 197 deg. F. enters the return system in which the 8-in. vacuum is maintained, part of it will immediately burst into steam. Now the condensate from the 75-lb. pressure unit heaters is discharged through the traps at a temperature of 320 deg., which is 123 deg. above the temperature corresponding to the pressure in the lines.

"There occurs immediately what we know as 'flashing,' that is, a large portion of the water turns at once into steam under the vacuum temperatures in the return. This effectively kills the vacuum and may even put pressure in the return until the steam formed can be made to lose its heat."

"Well, what in the world are we to do about this?" It looked bad. We had no idea that it made any difference so long as our traps did not leak as to whether the pressure behind them was one or a hundred pounds. One simply bought the proper tap for the pressure. Evidently, this was a wrong idea.

"The solution is simple," he said. "You can purchase what we call a flash tank. You can add radiation to your return branch before it strikes the return main, but I believe the easiest thing will be to reconnect your heater elements. This will sacrifice a few degrees in the temperature of the air from the blowers. Will that affect you seriously?"

"No, we do not think so," we said. "Two or three degrees there will not be noticed under the present factory working conditions. Show us what you have in mind."

"All right, I'll sketch your return connections as they now run from the five coils in each unit.

"The connections, as they now stand, come from each coil through a check and a line valve and connect to the common return through a union, on each branch. The common return runs to the trap. Now I'll sketch what I advise you to do.

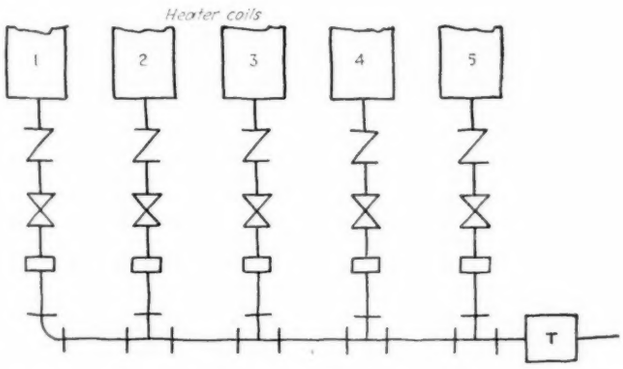


Fig. 1—Heating coils receiving steam at 75 lb. pressure connected so that trap returns flash in return main and destroy vacuum

"Disconnect the coil farthest from the cold air inlet from the high-pressure steam and from the common return to the trap, leaving the four remaining coils connected to the trap. Connect the trap discharge to the inlet side of the coil No. 5, and connect the discharge of coil No. 5 to the return main.

"You should really have another trap between coil No. 5 and the return main, but we can consider that later when we are talking about equipment essential and recommended.

"This arrangement permits coil No. 5 to act as a place for the flash to expand and will provide an excellent medium for putting the excess heat at points in the plant where your blowers deliver. I should like to know later how much temperature you lost in the fan discharge."

We measured it later that year and found the temperature a bit more than 2 deg. lower.

The plan of using the fifth coil to flash the condensate worked splendidly. We later put in the second trap as some steam carried over.

"As soon as that point is taken care of," said our very capable adviser, "your system will be balanced as far as

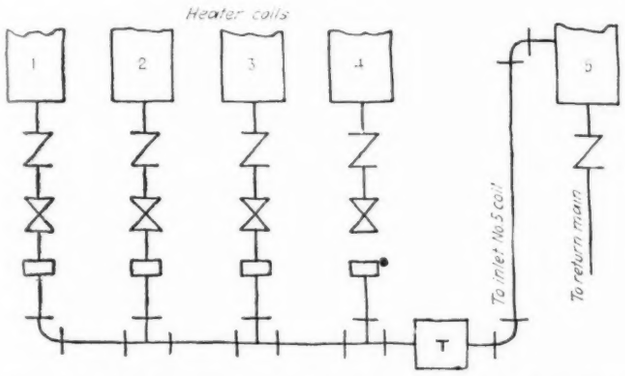


Fig. 2—Changes made in piping at heating coils to take care of flashing of condensate after the trap

return pressures are concerned unless a trap or a set of traps leak."

"Yes, that happens, also," we replied, "and it takes most of a man's time keeping track and locating the trouble."

"How many return branches are there on your return main?"

We referred again to our invaluable line layout and counted fourteen. These fourteen were the main branch returns which all came back to the pipe tunnel and were readily accessible where they connected with the main. Our plan in locating trap leaks in the past had been to go blindly through each department when trouble was indicated anywhere.

Thermometer Used to Locate Leaky Traps

"Arrange these returns so you can check at the main points in this manner," he next told us, "and you will save a lot of time.

"Put a tee in each line just back from the connection to the return header with the side outlet looking up. Weld wings on a plug for this outlet so you can place and remove it without using a wrench. Get a thermometer, one of the type with a protected stem and a perforated bulb shield. Fit this into a bushing that will take the place of the plug. Then you can go down the line of returns and check them by removing the plug and inserting the thermometer.

"When the temperature reaches much in excess of your vaporizing point, 197 deg. at 8 in. of vacuum, it will indicate that that return is blowing steam. Go back along that one line to find the faulty trap. If the return is very long, put plugged tees back along it at several convenient points."

We followed his advice, going so far as to place several thermometers permanently on the more important returns. Needless to say, they saved us a great deal of time and trouble.

"I have pointed out to you a representative example of the things that give trouble in your system," our engineer told us. "It is your job as I see it to use your layout to locate similar points that I have not named.

"Now we will talk about your vacuum pump that, from what I have seen of it, will require attention. Even with the return system corrected, you will not be able to maintain a vacuum because of the condition of this pump. Why, even now 90 per cent of your returns are being wasted to the sewer. Did you ever stop to think of what you get back when other things are equal if you invest it in a pump to retrieve the condensed steam?"

"We get a little warm water, that's all."

Returning Condensate Nets Large Saving

"That's not all by a long shot," he fired. And we saw he was getting away from the easy-going attitude he had held so far. "I wish you could be made to understand what a real investment a good vacuum pump is. Just let me use your case for example." He set down the figures we had given him.

Approximate pounds of steam condensed per hour during the heating season, lb.	18,000
Average return water temperature, deg. F	150
Average raw feed-water temperature, deg. F	60
Difference between heat in condensed steam and raw feed water, B.t.u. per hour	1,620,000
Per cent returns retrieved under old conditions	10
Actual heat retrieved from condensed steam, old conditions, B.t.u. per hour	162,000
Per cent returns retrieved with adequate pump	90
Added saving possible, B.t.u. per hour	1,312,200
Assumed heating value coal, B.t.u. per lb.	12,500
Useful heating value assumed at 70 per cent efficiency, B.t.u. per lb.	8,750
Added saving in terms of coal, lb. per hour	150
Possible saving in coal, lb. per 24 hours	3,600

"Now do you see any differently? If your lines are in good order as you are now putting them, and you will replace that vacuum pump wreck of yours, that's so typical of vacuum pumps in many industrial plants, you will save nearly two tons of coal each day of the heating season.

"You save actually more than two tons because there is no scale to drop out of this return water. It has already been deposited once. Is that not worth while?"

"We have never looked at it in just that way," we told him. It is worth while. Tell us what we need for an adequate pump assembly?"

"You need a pump of sufficient size to take care of maximum returns without laboring. Half again as big as the one you now are using is my guess, but we will figure that out later. You need a strainer ahead of the pump and a pump governor to hold the vacuum where it should be. You should order it as soon as possible, for the sooner it is in the sooner you will begin to save."

"You win," we said. "We are amply convinced, and our request for appropriation will be accompanied with plenty of convincing support, thanks to your example."

"Where do we go next?"

"Now, we'll look at radiator and coil locations and check your trap connections and see how things are fixed to keep the dirt in the system where it belongs. Then my service work will be practically completed and you will be ready to make your equipment program."

Elevator Doors Operated Electrically

THE problem of handling passengers efficiently by elevators may be divided into two parts; one, the actual transporting of them from one floor to another and two, getting the passengers on and off the car. The latter is as important as the former and in this the landing doors are an important factor. When the car arrives at a landing the more quickly the doors can be safely opened and closed the shorter will be the period the car will be required at a given landing. To this end power-operated landing doors are coming into extensive use.

Power-operated doors are made of two general types, those that are opened and closed by the operating machine and those that are opened by power and when released are closed by springs. Figs. 1 to 4 show one of the latter type built by Franz A. Boedtcher, New York City. The power for opening the doors, in this system, is obtained from an electric motor, and closing is done by springs that are compressed during the opening operation. The closing is done in the same way as on the standard type hand-opened self-closing doors.

The figures show a full-sized equipment mounted in the shop. The opening machine consists of a motor *M* connected to a shaft *S* through a reducing gear and chain drive, Fig. 3. On shaft *S* is a coil and a gear wheel *G*, Figs. 1 and 2. The coil is on the shaft back of the gear and is not shown in the figures. A second coil *C* is mounted below gear *G*. This equipment comprises the power unit and is mounted on top of the car.

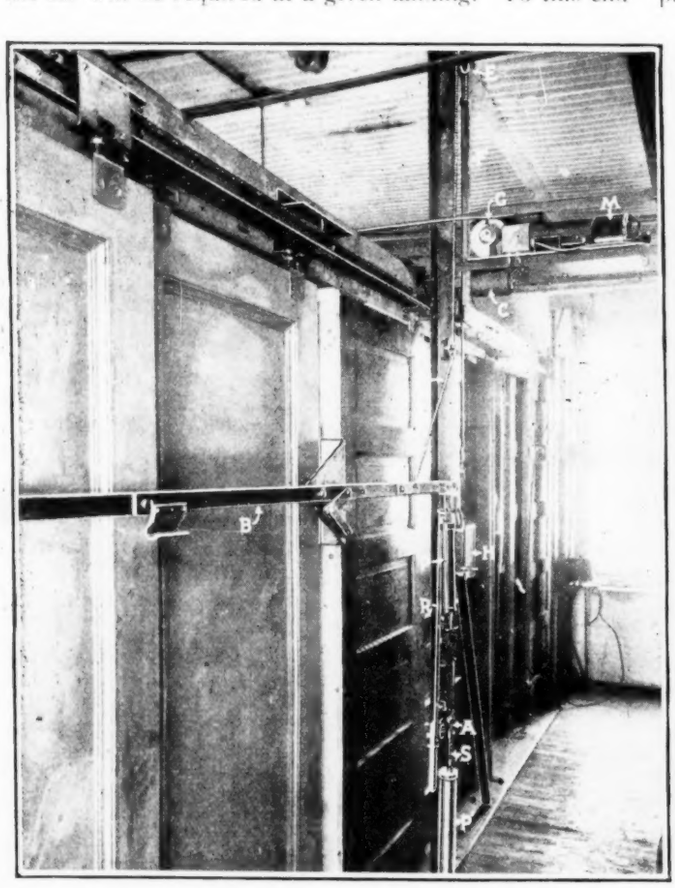


Fig. 1—Elevator doors in closed position

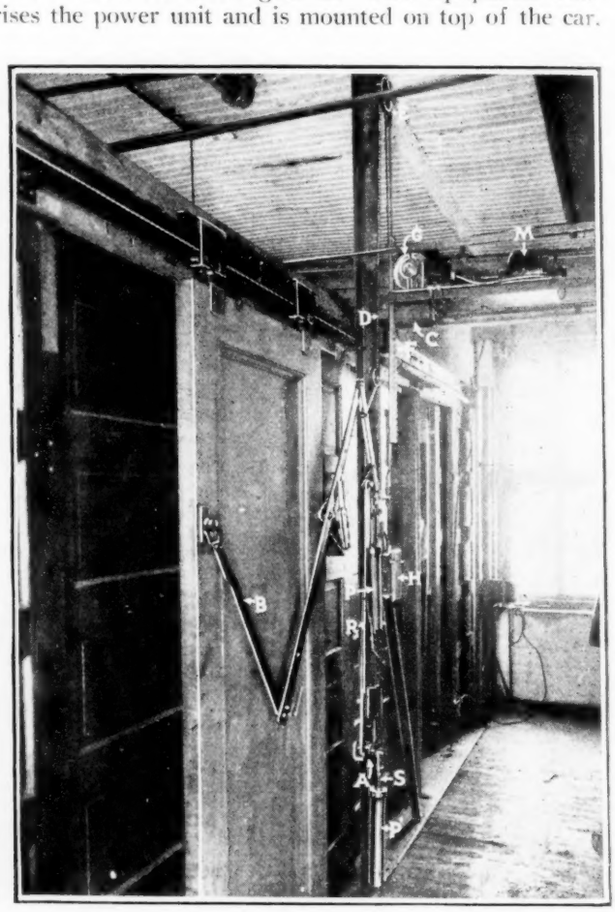


Fig. 2—Elevator doors in open position

On the landing doors is mounted the conventional type of opening and closing bar *B*, which is horizontal, as in Fig. 1, when the doors are closed and folded at the two joints, as in Fig. 2, when the doors are open. The fixed end of this bar connects to two combination spring and oil cylinders *P* and *P'*. The piston in cylinder *P* is connected directly to a bell crank near the fixed end of the operating bar and has its piston pulled upward as in Fig. 2. In this operation a spring within the cylinder is compressed, which supplies part of the power for closing the doors.

The lower cylinder P' is connected to the bell crank on the door-operating bar through a rocker arm A and a rod R. When the door opens, the piston in this cylinder is pushed downward and a spring S, on the piston rod, is compressed. The chief object of this spring is to give the doors a quick kick off at the beginning of the closing movement. The pistons in P and P' are arranged to allow a free flow of oil from one end of the cylinder to the other during a large part of the stroke in either direction. By the use of suitable ports the flow of oil is restricted near the ends of each stroke to smoothly and quickly retard the doors and give quiet operation. The door operating bar is connected by a chain D, which runs over a pulley E to a short length of rack F. This rack is free to move up and down on a guide bar.

Doors Controlled From a Switch

The doors are operated from the control switch H, which has two points. The first point to close energizes the magnetic coil on the gear shaft and magnetic coil C. Gear G is now magnetized, which in combination with magnet C attracts rack F and pulls it into mesh with the gear. Closing the second point on the control switch starts the motor which turns gear G in a counterclockwise direction and moves the rack down to the position shown in Fig. 2. This operation opens the doors.

Connected in the motor circuit is a limit switch L, Fig. 3. This switch is operated by a bell crank connected to an iron bar, I, which rests on the gear shaft S. The shaft being magnetized by the coil causes this bar to ride up on it as it turns and opens the limit switch to stop the motor when the doors are open.

As long as the control switch is held in the on position the magnet coils remains energized and the rack is held in mesh with the gear and the doors are held open

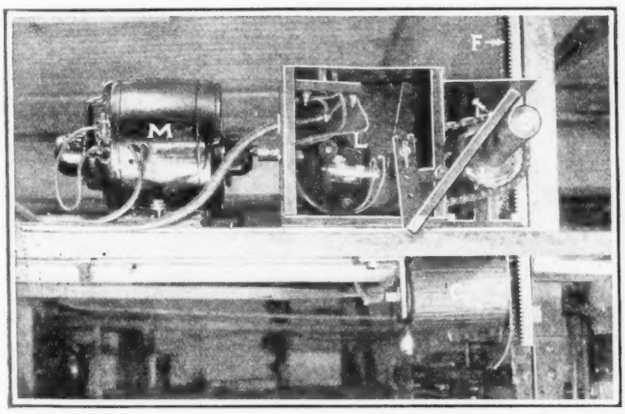


Fig. 3—Motor-operated landing-door opening machine

against the tension of the springs in the oil cylinders When the control switch is brought to the off position the rack is released and the springs in the cylinders P and P' close the doors as in the usual type of spring and oil-cylinder door closer. This allows the doors to close with an easy motion, but the force closing them is not sufficient to injure anyone who might get in their way when they were closing.

The sequence of events when opening the doors is made automatic by a controller, Fig. 4. The left-hand contactor is the first to close, which energizes the magnet-coil circuits on the door opener and also provides a circuit for the coil of the middle contactor on the panel. The middle contactor closing makes the circuit for the right-hand contactor coil. When this contactor closes it completes the motor circuit to open the doors. The middle contactor is used to give the proper time element between the closing of the magnet and the motor contactors.

The circuits are made between a carbon disk and square copper contacts. A rotating contact is made be-

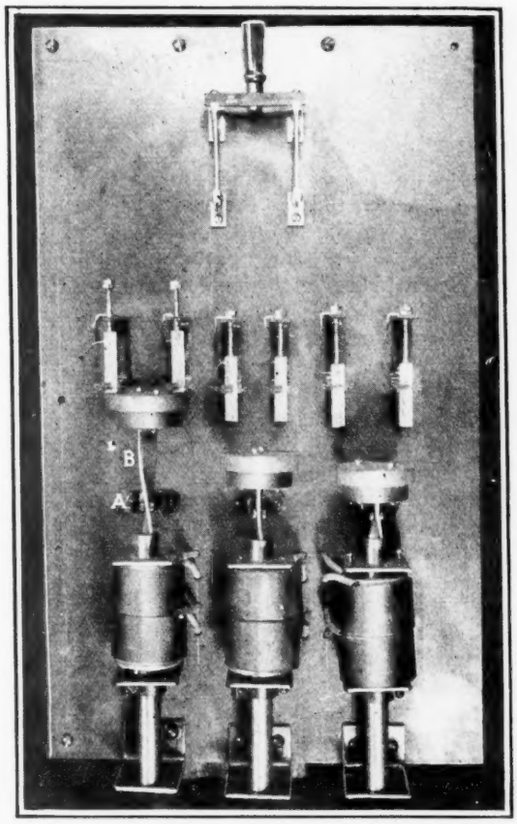


Fig. 4—Control panel for door-opening machine

tween the carbon disk and the copper contacts by using a flat-brass stem between the magnet core and the carbon disk. The brass stem B is twisted and runs in a guide A, so that when the carbon contact moves up and down it is caused to rotate about 120 degrees. This motion gives a rubbing action between the carbon and copper and insures a self-cleaning contact.

For Best Draft Conditions all junctions of the uptakes with the stack connection should be made with easy bends, so the flow of the gases may be smooth and without eddies, just as would be most favorable to the flow of water. To secure equalization of the drafts, each boiler uptake except the one farthest from the stack should be provided with a baffle to so direct the course of the gases that, when delivered into the main connection, their flow will be toward the stack before coming in contact with gases discharged from other boilers. Then the gases discharged from a boiler uptake with stronger draft will exert a jet-pump action rather than offer an obstacle to the discharge from the others. Of course each baffle must not obstruct the main connection more than the proportion of cross-sectional area to which its uptake is entitled.

Some Notes on Steam Turbine Development

III. Blade Proportions—Adoption of the Double-Flow Principle—Other Points of Design

By W. J. A. London

IN THE reaction turbine the length of the machine is proportional to the width of blade used. Experiments have shown that, apart from the mechanical stability of the blades themselves, there is little difference, at the low velocities used, in the efficiencies of the wide and narrow blades. Widths of $\frac{1}{8}$ and $\frac{3}{16}$ in. were used extensively in the earlier Parsons and later Ljungstrom machines. Three factors, however, govern the width of blade: the mechanical strength to resist bending and vibration stresses, the impracticability of obtaining the equal tolerances (tolerances meaning the discrepancies in blade dimensions), and lastly, the shop cost.

An interesting investigation was made some years ago in connection with this last item. Assuming that equal tolerance could be obtained throughout (blades having an equal efficiency irrespective of width), the narrow blade was found to be not commercially advantageous. A curve plotted on the basis of material plus labor and overhead, showed a high cost of the $\frac{1}{8}$-in. blade, the curve dropping to a minimum with a width of about $\frac{5}{8}$ in., and gradually ascending again.

THE third article in the series by Mr. London, in addition to a discussion of various experiences in the proportioning of blades, emphasizes the importance of the introduction of the double-flow principle. The article also points out some of the fundamental characteristics of the impulse turbine.

The Double-Flow Principle

One of the greatest innovations in turbine design, and one that has made the reaction type possible in such large machines as then built, was the introduction by the Westinghouse company of the double-flow low-pressure end, adopted in later years by practically all builders of the reaction machine, the principle also being introduced in many impulse designs.

The elimination by this construction of the low-pressure dummy was in itself of sufficient importance, so that further comment on the remaining points of merit is hardly required. The high and intermediate dummies could be kept reasonably tight, and, moreover, the leakage could be utilized in the active low-pressure blading. The design of suitable rotating dummy rings six feet in diameter that would remain true when subjected to changes of temperature was a hit-and-miss proposition. Designs on paper that promise the most successful results often turned out in practice to be the ones that would distort the most under actual operating conditions.

While the general subject of dummies is under discussion, a brief reference to the Kingsbury thrust bearing should be made. The development of this bearing, with the enormous loads it can carry, has been the means of easing up this dummy problem quite materially. Smaller diameters of dummy pistons are permissible, taking only a portion of the steam thrust, the remaining load coming within the capacity of the thrust bearing. In the superimposed cylinder construction referred to later, momentary unbalance pressures can also be taken care of.

Other advantages of the double-flow principle such as shortening the low-pressure blades, etc., are well known, but we are interested at this time principally in the effect of this construction on the design of the casing.

The double-flow principle, applied either throughout or in the low-pressure end only, makes possible a much more uniform design, resulting in better temperature distribution. Particularly is this true in multi-cylinder machines and individual low-pressure turbines, as may be noticed in Fig. 1.

Other Points of Design

In the high and intermediate stages, where the blades are shorter, the temperatures and densities higher and the necessity for fine clearances of greater importance, several modifications in design have of necessity been introduced to meet the difficulties encountered with higher operating temperatures.

The Westinghouse company has introduced internal rings in the casing for carrying the blading proper. These rings, by the nature of their symmetrical design and short lengths, retain their cylindrical formation better than could be expected from any design of the casing shell itself. They are fitted in such a manner that a material distortion of the outer shell does not directly affect the blade clearances. The construction of these rings and the method employed to hold them is shown in Fig. 2.

The innovation by the Parsons company some years ago of the so-called end-tightened blade in the high-

pressure stages, eliminates the necessity for fine radial clearances (the importance of which has been emphasized). In addition, this development is an acknowledgment of the difficulties encountered with the original design.

In any reaction turbine, fine clearances are necessary for each row of blades, on account of the drop in pressure through each row; therefore, regardless of whether

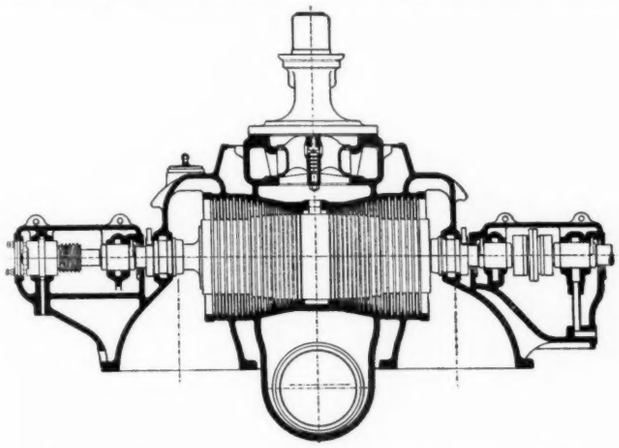


Fig. 1—Simple low-pressure double-flow turbine. Note symmetry of design

the losses are kept down by small radial or axial clearances, the necessity for tightness exists in either case.

This end-tightened system is preferably confined to the range of higher pressures where the diameters are relatively small and the difficulties encountered in maintaining given longitudinal limits are in no measure as great as in the disk or impulse type. There is, however, a limit to which this system can be carried, owing to the different expansion of the casing and the rotor.

It has been stated in favor of the axial clearance scheme that the rotor can be adjusted longitudinally by

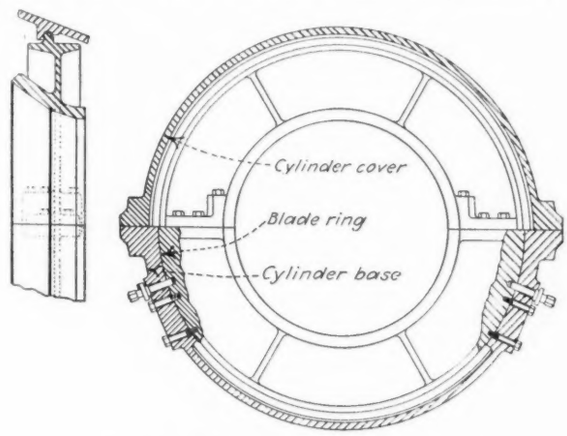


Fig. 2—Westinghouse blading ring

the setting of the thrust bearing to give larger clearances when starting, and that the clearance can be changed later at the discretion of the operator. Is this not, in reality, equivalent to another dummy setting? We are all acquainted with the old arguments that arose over "test-setting" and "operating setting." The arguments advanced with reference to the importance of maintaining casing "uniformity" do not, therefore, seem to be entirely overcome by this new arrangement.

From a strictly mechanical point of view the advantages of substituting a one- or two-row impulse wheel for the first-stage reaction element are evident. The large pressure drop in a short length, the confining of the highest temperatures to the nozzle chamber, the elimination of the dummy for this section, the shortened bearing span and the stiffened casing are the principal advantages.

In the purely impulse type of turbine, where liberal radial clearances are permissible, it would appear at first sight, from the arguments already set forth, that the advantages would be in favor of this class of machine with none of the mechanical difficulties encountered in the purely reaction type.

It is true that such items as "blade fouling" are foreign to the impulse type, but other problems arise fully as intricate as the design of the casing shell of the reaction machine. The result of misbehavior on the part of the casing is generally of a much more serious nature than the stripping of blades which can be quickly replaced. If the stripping is confined to a small section of the casing, as generally happens, the machine can, after the "schaufel salad" (as the Germans call it) has been cleared away, be put back into operation again until a convenient time arrives for reblading.

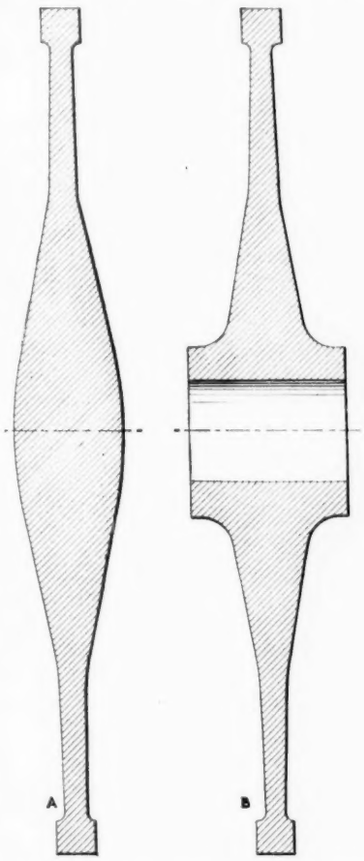


Fig. 3—A—Solid disk of uniform strength. B—Disk of same strength as in A but with hole bored for shaft

The fundamentals of the design now under discussion call for the length of casing, and consequently the shaft span, to be kept down to a minimum. All machines working on the impulse principle must necessarily be of the disk type. The shaft must be as small in diameter as possible for two reasons—to reduce the leakage losses between stages at the glands and to keep the wheel hubs as short as centrifugal stresses permit. In Fig. 3, which best explains this situation, *A* shows a solid disk of uniform strength, while *B* represents a disk of the same strength, but having a hole bored in the center of the disk for the shaft. A compromise, consequently, must be arrived at in covering the foregoing points. This is the reason why so many machines of this type are built with "flexible" shafts; that is, having normal running speeds higher than critical speeds.

A study of typical constructions of impulse turbines, both of British and American designs, points out the necessity for crowding the stationary and rotating elements as closely together as possible.

The design of the diaphragms, therefore, with the

limited space available, constitutes one of the most serious problems to be solved, on account of the large bending stresses they are subjected to. Where it is practicable to use solid diaphragms, which, of course, necessitates the removal of the wheels from the shaft for inspection and repairs, the design is not such a serious problem, as formulas for cylinder and boiler heads are applicable in this case; but in current practice, where the split construction is necessary, this is quite another question, as anyone who has worked the solution of the bending moment diagrams of such structures will agree.

As in the reaction machine the casing shell must be carefully considered so that any distortion here will not seriously react on the diaphragms.

One other point of difficulty met with in this type of turbine is the design of a satisfactory gland or stuffing box at the high-pressure end. In reaction machines both glands are subjected to low or exhaust pressures, whereas in the impulse type the inboard gland must be packed against the full working pressure of the first stage.

Rack for Storage of Pipe

BELIEVING that the appearance of a pipe shop floor reflects the character of the work being performed, the chief engineer of the Marion plant of the Public

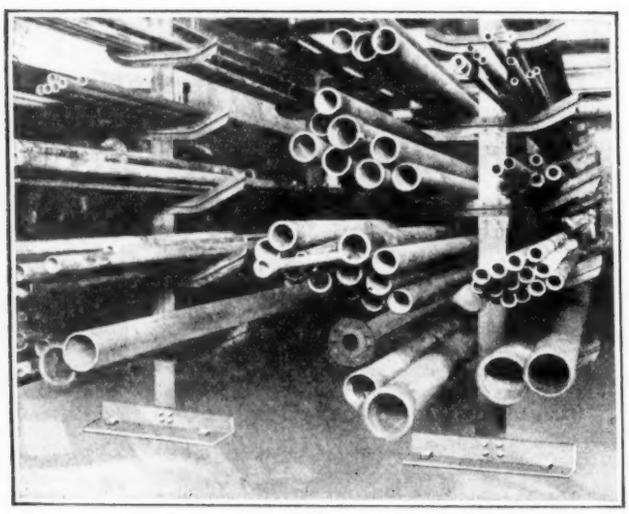


Fig. 1—Neat, sturdy and compact rack used by the Public Service Gas & Electric Company of New Jersey for the storage of pipe

Service Electric & Gas Company of New Jersey, erected a compact rack in the pipe shop for the storage of short and long pieces of pipe. Prior to the erection of the rack this material was scattered around the floor of the pipe shop, creating an untidy appearance.

The rack consists of four vertical 4-in. tees each of which is riveted to a 4-in. angle 24 in. long and in turn bolted to the floor. The tops of these vertical tees are tied together by a 3-in. angle iron. Four 2½-in. brackets varying in length from 20 in. to 31 in. are equally spaced on each upright for the support of the pipe and riveted by ⅜-in. rivets. Either end of these brackets extends upward about 2 in. to prevent the stored pipe from rolling off.

This rack occupies a minimum of floor space. It has been found effective for the storage of this material and has assisted in maintaining a better shop floor appearance.

Answers to What Do You Know

The questions are on page 389

Ans. 1—The wiper admits air into the intake manifold and thus slightly increases the air pressure during the suction stroke. This decreases the area of the exhaust-suction loop of the diagram. The slight increase in suction pressure increases the compression pressure, and with it the explosion pressure. This raises the expansion line and increases the area of the main loop of the diagram. Increasing the main loop and decreasing the lower loop indicates an increase in power developed in the cylinder.

Ans. 2—The explanation is that in the meter the effective voltage across the armature is constant, while in the motor the effective voltage across the armature is the applied voltage minus the counter electromotive force, which is a product of the speed and the field strength.

Ans. 3—The steam-valve reach rod of the head-end steam valve should be removed so that the steam valve will remain closed. The exhaust valve should be turned until it is open. The load should then be reduced to a point where the engine can carry it with only one end of the high-pressure cylinder taking steam. If the load cannot be reduced, the governor reach rod can be uncoupled so that the crank end will take steam full stroke, the speed to be controlled by the engineer standing at the throttle. This, however, is method to be used in an emergency only.

Ans. 4—The oil would back up in the fuel valve and fill the injection air line. As soon as the injection air was turned on, it would force the oil into the engine cylinder as long as the spray needle was open. The governor would not control the fuel charges, and the engine would overspeed until the oil in the air line had been consumed. To stop the engine, the quickest way would be to hook open the exhaust valves, followed by opening the spray valve bleeder cocks.

Ans. 5—Combustion occurs in pulsations coinciding with the natural period of the boiler. These pulsations are due in all probability to an imperfect mixture of air and oil and can be remedied by a target baffle or by rearranging the air registers. This does not refer to pulsations due to pipe vibration.

Ans. 6—Yes. With a proper arrangement steam, by blowing through a nozle over a body of water, will cause some of the water to evaporate owing to the removal of the existing water vapor over the surface and this will cool the remainder of the water.

Ans. 7—No. It has been found by experiment that the total pressure will be less than the sum, but greater than either.

Ans. 8—No matter how low the temperature, there will be some water vapor left.

Ans. 9—As the wires have a diameter of 0.0045 in., each mesh opening is 0.0055 in. wide, which is the limiting diameter of the coal particles.

Ans. 10—The difficulty is overcome by making the cable in the form of a tapering flat web, so that as the depth increases there is more material at the top of the cable to resist the increased weight of the cable below.

Central Station Versus Privately Generated Power in New England

Census Report Indicates Little Change in Relative Proportions During Last Five Years, Although Power Increases Have Been Large in Each

ONE of the most interesting and significant facts that have come out of the last Census of Manufactures, taken at the opening of 1926, is the relative use of central and privately generated electrical energy for power purposes in the manufacturing plants of the nation. A special tabulation of this portion of the Census was made for the industries in the New England States and for the 29 leading industrial centers of this section. A summary of this detailed tabulation is given in the accompanying table. A more detailed study of the whole question is being made by the New England Central Station Association of Power Engineers, based upon the Census Bureau's tabulation of New England industries.

The summary figures for New England as a whole show that the central station made large gains on the private generating plant during the five-year period 1914-19, but that since 1919 the percentages have remained practically the same; the motors driven by purchased energy showing a slight drop of one per cent. During this last period the central-station motor-connected load was increased by 585,250 hp. and the private motor load by 437,850 hp. In three of the states—Maine, New Hampshire and Vermont—the private plants gained during this period on the central station in percentage of total motor connected load, and in three states—Massachusetts, Connecticut and Rhode Island—the central station increased its lead. In two of the states—Maine and New Hampshire—over half of the total connected motor load is credited to the private plant. New Hampshire presents the outstanding case for the private plant, only 21 per cent of the total connected load being now served with central-station energy. New Hampshire is also the only state showing an actual decrease

THE STATUS OF THE PRIVATE GENERATING PLANT IN NEW ENGLAND

State and City	Number of Manufacturing Plants			1914			1919			1925		
	1914	1919	1925	Motors Driven by Purchased Energy, Hp.	Motors Driven by Privately Generated Energy, Hp.	Per Cent Driven by Purchased Energy	Motors Driven by Purchased Energy, Hp.	Motors Driven by Privately Generated Energy, Hp.	Per Cent Driven by Purchased Energy	Motors Driven by Purchased Energy, Hp.	Motors Driven by Privately Generated Energy, Hp.	Per Cent Driven by Purchased Energy
New England	25,193	25,528	18,173	419,197	688,480	38	1,147,336	796,265	59	1,732,586	1,234,115	58
States:												
Maine	3,378	2,995	1,500	46,344	61,356	43	94,164	72,047	57	140,060	150,991	48
New Hampshire	1,736	1,499	1,038	49,171	53,441	48	84,847	67,117	56	47,296	181,647	21
Vermont	1,772	1,700	951	27,477	19,684	58	61,858	12,298	84	69,773	32,730	68
Connecticut	4,104	4,872	3,062	64,294	111,715	37	242,765	154,573	61	399,116	190,062	68
Massachusetts	12,013	11,906	10,027	200,339	382,632	34	564,417	424,274	57	888,713	577,135	61
Rhode Island	2,190	2,466	1,595	31,572	59,652	35	99,285	65,956	60	187,628	101,550	65
Cities:												
Massachusetts												
Beverly	67	70	44	308	387	44	2,945	43	99	2,554	248	91
Boston	3,138	3,077	2,620	31,492	22,184	59	56,432	19,607	74	83,265	33,889	71
Brockton	243	217	264	2,989	1,349	69	7,768	807	91	9,656	1,597	86
Cambridge	316	339	352	6,095	10,200	37	12,193	9,856	65	25,513	14,819	63
Fitchburg	137	121	103	12,397	1,791	87	19,708	1,028	95	24,993	3,965	86
Haverhill	398	405	444	3,351	465	88	7,469	503	94	8,461	1,861	82
Lawrence	221	194	177	2,192	52,988	4	5,137	74,283	6	11,982	87,965	12
Lowell	300	291	257	3,868	31,239	11	11,188	36,351	24	26,410	47,438	36
Lynn	429	442	342	4,186	19,438	18	8,376	29,800	22	12,997	44,070	23
Malden	92	108	98	691	1,135	38	3,047	918	77	5,394	1,374	80
New Bedford	233	267	200	1,636	25,321	6	30,588	27,720	59	89,632	26,559	77
Pittsfield	84	90	61	1,341	31,612	4	3,806	31,652	11	7,471	39,164	16
Revere	27	31	18	68	5	93	178	5	97	104	5	95
Salem	178	153	114	3,848	137	97	10,858	201	98	13,698	205	99
Worcester	606	618	518	26,619	9,870	73	52,184	18,061	74	88,424	5,134	94
Fall River	315	293	238	6,045	12,173	33	18,188	13,623	57	46,062	20,876	69
Springfield	395	401	335	8,413	5,138	62	18,459	4,695	80	32,077	2,495	93
Maine:												
Bangor	122	106	58	540	153	78	1,159	126	90	1,588	0	100
Lewiston	98	109	78	1,278	2,300	36	2,302	4,723	33	8,484	16,975	33
Portland	296	308	179	4,048	1,156	78	7,299	1,875	80	11,289	50	99
New Hampshire:												
Concord	86	76	52	3,755	311	93	3,944	125	97	6,137	125	98
Manchester	151	165	128	4,834	30,577	14	9,732	30,465	24	6,403	50,053	11
Vermont:												
Rutland	65	64	36	1,389	387	78	2,945	43	99	2,554	248	91
Connecticut:												
Bridgeport	405	443	329	8,247	18,043	31	33,306	23,188	59	51,488	23,767	68
Hartford	380	504	337	11,722	3,260	78	26,526	3,364	89	42,802	3,543	92
Meriden	127	162	92	2,177	1,591	58	5,818	2,362	71	10,740	1,836	85
New Britain	120	116	87	1,238	6,366	16	14,090	6,380	69	15,754	12,696	55
Waterbury	190	253	156	13,241	21,665	38	13,208	11,059	54	51,470	31,557	66
Rhode Island:												
Providence	1,207	1,274	806	13,352	15,976	46	35,707	13,683	73	54,002	25,058	68

in central-station connected motor load during the period 1919-25.

Of the 29 leading industrial centers of the New England States, eleven reported an increase for the period 1919-25 in the proportion of the total connected industrial motor load served from private generating plants, seventeen report a gain for the central station during that period, and one reports the same condition at the end of the period as at the opening. The greatest strongholds of the private plant appear to lie in Manchester, New Hampshire, where 89 per cent of the connected motor load is served by private plants, and Lawrence, Mass., which reports an 88 per cent private plant service. In ten of these industrial centers the central station has more than 90 per cent of the connected motor load. Bangor, Maine, is the only center reporting a 100 per cent central-station load. Four of the centers—Manchester, Lewiston, Haverhill and Fitchburg—reported an increase in the proportion of private plant load for the period 1919-25.

Ground Alarms for Three-phase Systems

By E. H. STIVENDER

GROUND detectors have played an important part in the operation of power systems for years, and their usefulness is often underestimated. Of course many high-tension transmission systems are star-connected and operate with the neutral permanently grounded; this practice is manifested by the production of large transformers with one high-tension side grounded inside each

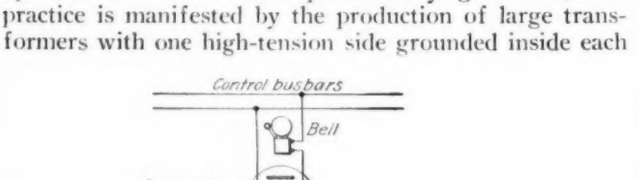
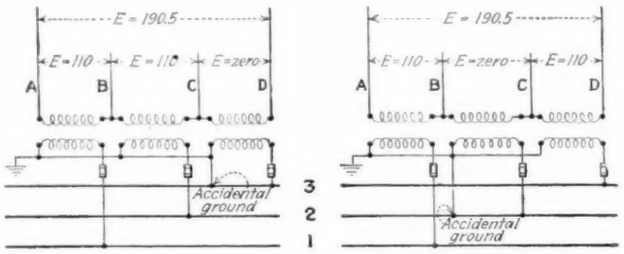


Fig. 1—Potential-transformer system of ground alarm for underground three-phase busbars

single-phase tank, thus eliminating a high-voltage bushing. But it has become common in modern installations to operate the auxiliary power busbars without a neutral ground. It is considered less expensive to insulate for full voltage to ground than to chance an interruption of service by a short-circuited phase because of a grounded line, which is more likely to occur than the crossing of two lines. Even when the house generators and house transformers are star-connected, in most cases no provision is made for grounding the neutral. When a grounded phase is detected, the fault can usually be taken care of without interrupting service or it may be left until the equipment can be spared.

The electrostatic ground detector, which can be seen on many 2,300-volt switchboards, is the most usual type. The pointers are arranged to indicate on a scale the condition of the ground—whether it is direct or through a resistance—but no provision is made for sounding an



Figs. 2 and 3—Conditions in the system of Fig. 1 when one phase is grounded

alarm when the difficulty arises. It is also necessary to bring leads of a dangerous voltage to the switchboard when the instrument is used with high-tension equipment.

As it is now general practice for all switchboard equipment to operate at not over 250 volts, potential transformers are employed to operate indicating lamps in some stations. One fault of this system is its failure to indicate the magnitude of the voltage to ground as the electrostatic instrument does. If a partial ground occurs, however, the lamp corresponding to that phase will not be so bright as the others. Fig. 1 shows the connections of this type of ground detector. The connections are star on the primary side with the neutral grounded, while the secondary is a modified closed delta. The indicating lamps are of equal candlepower and rated at 110 volts. Under normal operating conditions with no grounds on the 2,200-volt system the lamps will operate at 63.5 volts, which causes them to light dimly. An over-voltage relay is placed in one junction of the delta connection; the normal voltage across it will be zero and the contacts operating the bell circuit will be open.

When a ground occurs on one phase, the voltage across the potential transformer connected to that phase is zero and line voltage is impressed on the other two transformers, as shown in Figs. 2 and 3. Their secondary voltages are thus 110, and are 120 deg. apart. The voltage across the bell-ringing relay is therefore 1.732×110, or approximately 190.5 volts. The impedance of the secondary of the transformer on the grounded phase is negligible as the primary is short-circuited, and the new voltages are not affected by it. In this way the bell is sounded and the grounded phase is indicated by one dark lamp, while the other two are bright.

The overvoltage relay must be responsive to weak currents as well as the current at maximum voltage, for many grounds are through a resistance. The relay is therefore made of the induction type, which satisfies this requirement.

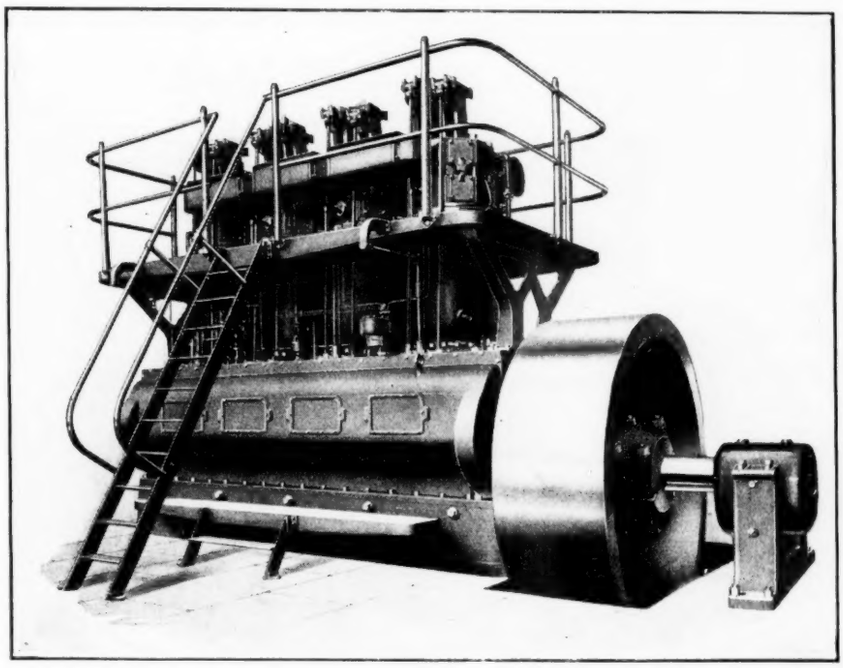
This system for detecting grounds has the additional advantage that it is made up of standard equipment that can generally be picked up around the plant. This makes it easy to keep the apparatus in working condition, since if any part goes wrong it can be replaced by a spare.

Paper Mill Uses Diesel Engine

A 400-H.P. Solid-Injection Oil-Engine Supplies Excess Power Needed by Mill—Steam Engine Exhausts into Heating Lines—Load Is Balanced Between the Two Units

BECAUSE a paper mill has need for a large amount of steam for drying purposes, the current thought is that steam power proves the most economical. That this is not always true is evidenced in the results obtained by the Rogers Paper Co., of Manchester, Conn., in its combined steam- and oil-engine plant.

This company devotes its entire energy to the manufacture of special paper board for electrical insulation work. As the paper must have a high dielectric strength, it is made chiefly from rags with a certain amount of paper cuttings. The paper is decidedly spongy and acts somewhat as a blotter in holding an immense amount of moisture which the rolls cannot squeeze out. The drying, as a consequence, requires considerably more heat than in the case of ordinary paper. Since a ton of paper board going to the driers contains 1,500 lb. of water, the driers required over 1,500,000 B.t.u. per ton of paper, or about 1,500 lb. of steam is needed per ton of raw paper board. Using steam from the exhaust of an engine whose water rate is 30 lb. per horsepower-hour, the engine rating to give sufficient exhaust steam per ton of paper per hour would be 50 hp. If the power needed per ton were no greater than this, power costs would be an insignificant factor in paper making, for in each pound of steam leaving the engine there is as much heat as was in the live steam going to the boiler, less 85 B.t.u., which makes the engine chargeable with not over 10 per cent of the steam generating costs.



The 400-hp. Ingersoll-Rand engine on the test floor

Unfortunately, about 100 horsepower-hours are needed per ton of paper. How this extra power is obtained varies in different mills; some have water power available, others use condensing steam engines, some have installed bleeder turbines and draw off the process steam from one of the turbine stages. Other mills, especially those in New England, purchase the excess power, as water powers are not large enough and coal is expensive. The final method is the use of Diesel engines in conjunction with a back-pressure steam engine.

Formerly, the Rogers paper mill obtained all its power from a 24x48 Rollins releasing-gear grid-valve engine; the steam was supplied by a 84-in. by 18-ft. and a 72-in. by 18-ft. horizontal return-tubular boiler at a pressure of 125 lb. gage. With increase in output and improvements in drying, the power requirements became twice the heating requirements, and it would not be efficient to operate the engine at a long-range cutoff to give the extra pressure, for this would mean that half of the exhaust steam would pass out of the atmospheric relief valve. Other plans examined included purchased power, a bleeder turbine and oil-engine power, and after much study the oil engine was installed. This is a four-cylinder four-stroke-cycle Ingersoll-Rand solid-injection Diesel belted to a lineshaft. A load balance is maintained between the steam engine and the Diesel so that the steam engine carries enough load to supply the drying steam needed, but as soon as the back pressure begins to rise above 10 lb. gage, which would ultimately raise the atmospheric relief, the Diesel takes more of the load.

The variation in power demand is such that the Diesel load ranges from 300 to 450 hp. This is carried with ease, although the engine is operated 24 hours a day, seven days a week, with the exception that it is shut down on Sundays from 7 a.m. to 6 p.m. During this time the engineer goes over the machine and makes any adjustment deemed necessary.

The fuel consumption does not vary much from 600

gal. a day, with an average load of 400 hp. This means that approximately 13 horsepower-hours are obtained per gallon of fuel oil costing 5.75c. per gal., or the fuel expense is 4.4 mills per horsepower-hour. The lubricating oil expense is 0.3 mill per horsepower-hour. Labor may be disregarded, inasmuch as the engineer in charge of the steam plant attends the Diesel; consequently, no additional labor charge need be figured. Repairs have been absent and maintenance costs so low as to have no perceptible effect on operating costs. Including fixed charges, the cost of Diesel power is about 0.7c. per horsepower-hour, or slightly over 1c. per kilowatt-hour. This compares favorably with the existing rate of 2½c. per kilowatt-hour for purchased current.

While the Rogers mill is by no means the largest in the country, its experience should be of value to other mills that must obtain more power or wish to reduce present costs.

The engine has four cylinders 17¾x22 in. mounted on a cast-iron frame which in turn rests on the base carrying the crankshaft bearings. Combustion takes place in a cavity in the cylinder head communicating with the cylinder proper. The fuel enters this chamber through two spray nozzles fed by a single oil line from the distributor. Only one fuel pump is used, and this is geared to run at twice the engine speed, so that four pump strokes are made during each two revolutions making up a complete cycle. The pump discharges into a distributer box containing a disk that is so rotated that the line to each of the cylinders is placed successively in communication with the fuel pump.

Combustion is on the dual principle, part taking place at constant volume, raising the cylinder pressure from 330 to a maximum of about 500 lb., followed by combustion at constant pressure of the rest of the oil spray.

Explosions Caused by Oil Vapor

By Edward Ingham, A. M. I. Mech. E.

THE formation of oil vapor in steam-engine crankcases, air compressors and other power-plant machinery has been responsible for numerous explosions. Oil vapor, when mixed with a certain proportion of air, forms a highly explosive mixture, which, if ignited, may cause considerable damage.

Engine explosions due to oil vapor mostly occur in connection with high-speed vertical engines with inclosed crankcases and splash lubrication. The trouble is brought about by the continual splashing of the crank into the oil, causing the latter to vaporize and, with the air, form an explosive mixture in the crankcase. Under normal conditions of working this explosive mixture does not constitute any danger, because the temperature within the crankcase is insufficient to ignite the mixture. If, however, overheating should occur at the crosshead guides, the temperature developed may be sufficient to produce ignition.

In one case a crankcase door had been left open, and the oil vapor, escaping into the engine house, accumulated overhead. An explosion first occurred in the crankcase, and this in turn caused the explosive mixture that had formed at the top of the engine room, to explode, as a result of which the building caught fire. In another instance the attendant opened the crankcase door and, to inspect the parts, thrust in a naked light, which caused the vapors to ignite and explode.

It is evident that the risk of these explosions may be eliminated by keeping the crosshead properly adjusted and lubricated and by keeping naked lights away from the crank chamber. An efficient system of ventilation would insure the removal of all oil vapor and air from the engine frame.

Explosions due to oil vapor are more likely to occur with air-compressing plants than with steam engines, the principal reason for this probably being that considerable temperatures are developed in the cylinder due to the compression of the air, so that, should an explosive mixture form, it is very likely to become ignited. The oil vapor is of course derived from the oil used for lubricating the cylinders. This is carried over into the mains and the receivers, which, if not frequently cleaned, may become thickly coated with oil on their interior surfaces. In some instances violent explosions have occurred through the oil vapor having combined with air in just the proportion necessary to form an explosive mixture, but in others, there has been merely an ignition of the oil followed by a slow burning.

When the vapor merely fires and burns slowly, no serious harm may occur. One or two cases, however, are on record where a fire in the air receiver caused overheating and weakening of the plates, which consequently failed under the pressure.

The liability to these accidents can be greatly reduced by using suitable oils and by restricting the quantity to the absolute minimum required for efficient lubrication. Undoubtedly, the use of cheap oils of unsuitable quality has been responsible for many explosions.

Many attendants do not realize that an air-compressor cylinder requires very little oil, as compared with, say, a steam- or a gas-engine cylinder, and often feed in several times as much oil as is really necessary. In a steam cylinder the oil is largely washed away by the steam, while in a gas-engine cylinder it is largely burnt away, so that in each case a comparatively large quantity must be supplied. In the case of an air-compressor cylinder, however, the oil is neither washed away nor burnt away, and only a little is required. Hence it is folly to feed in large quantities.

Occasionally, an attendant will introduce oil through the inlet valves. This practice is particularly objectionable, because the oil is quickly vaporized during the suction stroke and an explosion is likely to take place. In some cases kerosene has been introduced for cleaning purposes, but this is a dangerous practice, because kerosene vapor fires at a comparatively low temperature.

In the 1924 Technical Report of the British Engine, Boiler & Electrical Insurance Co., Ltd., of Manchester, an interesting account is given of an explosion of a two-cylinder vertical open-type oil engine. The explosion occurred in one of the cylinders while the engine was being started up.

The engine had been left standing three days, the cocks between the fuel pump and the tank having been left open. The attendant, prior to starting the engine after the stoppage, barred it round, with the indicator taps open and the blast air on. As he observed oil vapor blowing out through the taps, he continued to bar around until all evidence of the vapor disappeared. Nevertheless, a mixture of oil and air must have remained in the cylinder, since the explosion occurred immediately or just before the fuel valve opened. A considerable quantity of oil was afterward found on the top of one of the pistons and a certain amount on the skirt of the other.

Glauconite in Water Softening

By R. H. Emerick

The author distinguishes between Glauconite and Zeolite and presents evidence to show that it is the former and not the latter that possesses water-softening properties. Its origin and preparation are also discussed.—Editor.

ALONG toward the middle of the last century someone discovered that certain greensands, already encountered here and there throughout the world, possessed the peculiar faculty of making soft a limited quantity of hard water when the two made contact. From then until the close of the century much was tried and little accomplished in the creation of an apparatus that would successfully harness the greensands to the needs of industry. The combination of greensand and operating appliance that we know and depend upon today, is of comparatively recent birth. Preparation of the mineral is largely a matter of cleaning and color stabilizing, as in the past, while the apparatus itself is the descendant of numerous trial forms.

It is customary to refer to a greensand water softener as a zeolite softener. Strictly speaking, this is incorrect. Zeolite is the family name of an extensive group of minerals, in which glauconite, the characterizing constituent of greensand, has no place. Zeolites are crystalline in form, very porous and may be considered as having a feldspar and quartz ancestry. The name is formed from the Greek and means a "boiling stone," and the christening was performed by a Swedish mineralogist called Cronstedt in 1758. He created the name, apparently, to describe the nature of the mineral when exposed to heat, at which time it releases much of its water of crystallization accompanied by a variable degree of intumescence. Chemically zeolite is a silicate of alumina.

The origin of glauconite is not entirely explicit. Deposits are most frequently littoral or marine, which would suggest some relationship to or dependency on sea water. The mineral appears granular in form when separated from its matrix of mud, and is predominately green in color, although irregularities of shade are numerous, due to impurities included or to the oxidation of the iron content. Chemically, glauconite is a silicate of iron or potassium, with aluminum present in unfixed proportions. Tests of various commercial glauconites for water-softening service have indicated that, on a quantitative basis, the silica approaches 50 per cent, iron oxide 25 per cent and the aluminum oxide 14 per cent.

Greensand beds exhibit stratification, and samples taken from the various strata indicate that a marked diversity of exchange value may be found in the same bed. Preparation for the market is fundamentally a process of cleaning, screening and color fixing. Untreated mineral will deliver green water, and the intensity of the color increases with a rising temperature. Some glauconites offered for water-softening service will begin to yield color at 100 deg. F., and their use should be avoided with waters of this or higher temperatures. However, a mineral of this character is likely to possess a high power of exchange and might be pre-eminently desirable for low-temperature work. Most of the marketed glauconites will deliver clear water up to 200 deg. F. and even then the color is slight. Minerals in this group have received a treatment that might be called casehardening, and as a rule their exchange value is comparatively moderate, around three thousand grains of hardness per cubic foot, while the lower temperature classes frequently exceed four thousand. This initial exchange value does not decrease apparently with usage in either type; there are many softeners of various manufacture that are still operating at their original capacity after a decade of service on the one filling of glauconite and without marked change having taken place in the physical appearance of the mineral. That erosion and attrition are encountered, is indicated by the sharp irregular edges of the grains after long service, and there is a noticeable lack of very fine stuff suggesting that some is carried away by the water passing through. Slime, which might be expected, does not form apparently with the use of filtered water, and the absence of mud or other sediment after a protracted space of normal activity points toward insignificance of filtration.

Exhaustion of Glauconite Progressive

The exchange record of a given quantity of finished glauconite, when shown graphically from the beginning of a water-softening operation to the moment of exhaustion, is shaped much like the letter U. That is, the hardness of the discharged water falls off to the minimum soon after starting and continues at this value until exhaustion is imminent, at which point the line of hardness turns abruptly upward and follows a sharp angle of ascent until no further exchange of sodium can take place. The swiftness with which exhaustion becomes complete once the first sign of its approach appears, is the result of the nature of the exchange process. The mineral grains are not porous and the transfer of sodium to water and calcium or magnesium to mineral, is a surface action and practically instantaneous. Exhaustion therefore is progressive, and its passage through a bed of glauconite is like the regular and comprehensive movement of a curtain.

Glauconite, when ready for service, weighs on the average, about ninety pounds to the cubic foot, although a 10 per cent variation of this figure has been noted in the product of a few manufacturers. The weight gives no evidence of having especial significance in the efficiency of the mineral, but it does possess some importance from the viewpoint of price, for glauconite is sold on a per pound basis. Prices range between five and thirteen cents per pound for a reasonable quantity.

Glauconite for water-softening service is usually guaranteed by its maker to deliver water having a hardness of not over ten or twelve parts per million in terms of calcium carbonate. While this guarantee is usually satisfactory, it is on the whole likely to be conservative, and the soft-water output will run actually several parts less during a fair portion of the time.

Data on Coal Preparation at Trenton Channel Plant

By Joseph H. Drake
Boiler Room Engineer, Trenton Channel Station, Detroit Edison Company

THE Coal Preparation House at the Trenton Channel plant of the Detroit Edison Company was first started in June, 1924, and since then has been in steady operation. Careful records have been kept of performance, energy consumption and costs since Jan. 1, 1925.

The preparation house was described in detail by the author in the Nov. 2, 1926, issue of *Power*. Briefly, coal is crushed in a breaker and delivered to a bunker at the top of the preparation house. From the bunker the coal is fed by gravity to two lines of seven mills located on the ground floor. Each pulverizing unit consists of a mill, exhauster fan and cyclone separator. The pulverized coal from the cyclone separator is collected by screw conveyors and delivered to a hopper over the coal pumps that distribute to bunkers in the boiler house.

In November, 1926, a new section of the mill house, which is essentially separate from the old section, having its own driers, screw conveyors, drier exhauster fan, etc., was put into service. This new section contains four mills. With one exception the arrangement of the apparatus contained in the new portion of the house is the same as in the old section. In the first section the coal dust from the driers and from the cyclone-separator vents is removed by means of an air washer, while in the new section a pair of dust separators arranged in series are used to separate the coal from the air, returning through screw conveyors some of the coal that would otherwise be lost.

Each piece of vital equipment—drier fans, pulverizing mills, together with their exhauster fans, screw conveyors, coal pumps, air compressors, and building lighting bus—is provided with an integrating watt-hour meter from which the energy consumption per ton of coal for each piece of equipment is calculated. Condensed steam from the driers and heating system is measured by water meters located at the discharge of the trap line header. Coal is weighed on track scales in the yard, and the total coal milled is this figure plus or minus a correction for the bunker readings at the beginning and end of the month. The mill hours and pump hours indicate the number of hours run by all mills and pumps as recorded on the millhouse log. The accompanying curves show the performance and cost data on the various coal-preparation equipment.

Early in 1926, owing to the worn condition of mill thimbles, rolls and rings, the coal fineness and energy consumption fell off and the mill capacity increased. In March it was decided to overhaul all the mills, renewing thimbles, rolls, rings, casing and piping wherever necessary. This program, completed in July, 1926, showed immediate results, as evidenced by the trend of the curves. The curves for November and December, 1926, include the data obtained from the performance of the new section.

During the year 1926 a total of 423,906 tons of coal was pulverized. To accomplish this the mills operated for 63,031 hours, and to distribute this amount of coal the coal pumps operated 6,319 hours.

Since the first complete overhaul it has been the practice to keep two maintenance men steadily at work on the mills. By this method the mills are kept at a more nearly uniform degree of wear, and the fineness of the coal is practically constant. Also the maintenance cost per month is approximately the same over long periods.

The problem of exhauster-fan blade replacement is ever present. The average life of 79 sets of exhauster-fan blades is 1,245 mill hours each. Boiler-plate steel blades of $\frac{5}{16}$ in. thickness are at present being used as standard. Three-eighths inch blades have been tried, with the result that they sometimes get out of balance before actually wearing out. Many different materials have been tried, including Micarta, rubber, brass, copper-plated steel, manganese steel, dredge-plate steel, welded plate, and glass-coated steel, none of which has given better results than boiler-plate steel.

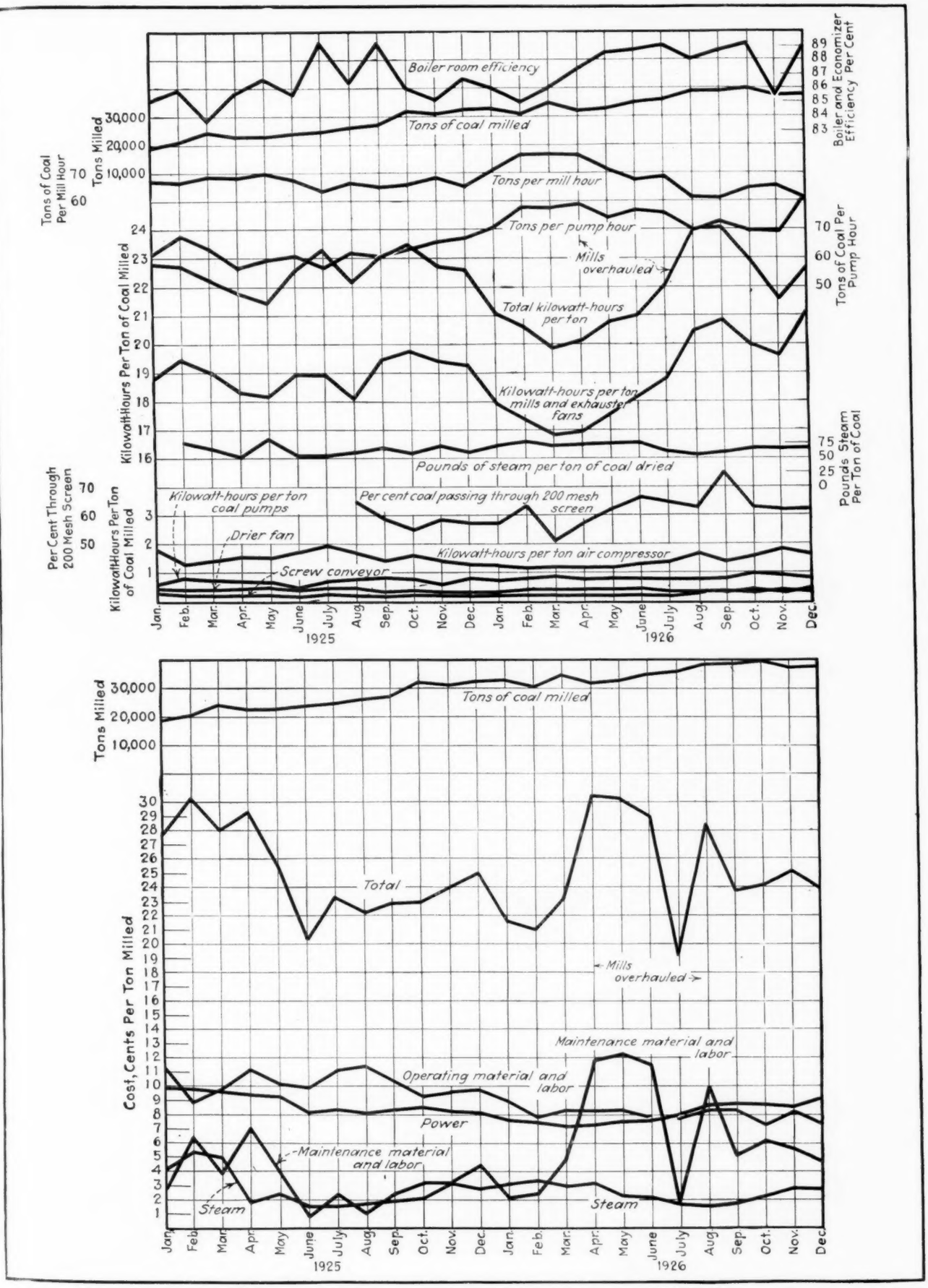
The life of grinding rings and rolls has so far been about 6,000 hours. The wear plates in the exhauster-fan casings and in the air passages to the mills have been renewed once or twice in three years of operation. The life of plow points is about 1,300 hours. These figures refer to the six-ton, six-roll type mill, of which there are seventeen in operation.

The coal pumps require regular cleaning of the thrust and radial bearings and occasional replacement. The flights on the screw wear down at the discharge end of the pumps and at intervals are built up by electric welding. These pumps are rated at 50 tons per hour with a 60-hp. motor, but are being used in regular operation at 60 to 75 tons per hour and have been equipped with 100-hp. motors to take care of the extra load.

Pulverized coal bins show only slight deterioration. The ceilings and upper parts of the bins have been painted to prevent oxidation, which was more rapid there than in the lower part of the bins.

A coal-height indicator has been installed in each pulverizer coal bin to give an approximate check on coal levels. It consists of a 9-in. aluminum sphere, suspended by a small brass cable and counterweighted so as to rest normally just under the ceiling of the bin. It can be lowered by an operator and the coal level determined by the position of a pointer fastened to the counterweight, when the sphere reaches the coal in the bin.

Indications are that the only extraordinary maintenance charge in the future will be the renewal of cyclone separators and piping.


Boiler room efficiency
Tons of coal milled
Tons per mill hour
Tons per pump hour
Mills overhauled
Total kilowatt-hours per ton
Kilowatt-hours per ton mills and exhauster fans
Pounds of steam per ton of coal dried
Kilowatt-hours per ton coal pumps
Per cent coal passing through 200 mesh screen
Drier fan
Kilowatt-hours per ton air compressor
Screw conveyor
Tons Milled
Boiler and Economizer Efficiency Per Cent
Tons of Coal Per Mill Hour
Kilowatt-Hours Per Ton of Coal Milled
Tons of Coal Per Pump Hour
Pounds Steam Per Ton of Coal
Per Cent Through 200 Mesh Screen
Kilowatt-Hours Per Ton of Coal Milled
1925
1926
Total
Maintenance material and labor
Operating material and labor
Power
Steam
Cost, Cents Per Ton Milled

Operating and cost data on coal preparation at Trenton Channel

Recovering Waste Heat From Coke By Dry Quenching

Brief Description of the Sulzer Process as Installed at the Plant of the Rochester Gas & Electric Corporation

WHEN announcement was made recently that International Combustion Engineering Corporation had acquired the American rights to the Sulzer Process for dry quenching coke for waste-heat recovery, it became apparent that many American engineers in the power field were not familiar with the process. Hence an editor of *Power* immediately visited the only installation of the kind in this country, that at the gas plant of the Rochester Gas & Electric Corp., for the purpose of securing data. This installation has been in successful operation for a little less than a year.

Briefly, the Sulzer Dry Quencher Process consists of recovering the sensible heat of the coke through the medium of inert gases (in this case the products of combustion) which then pass through a specially designed waste-heat boiler. Fig. 1 is a photograph of one of the two units at Rochester, each consisting of a boiler, a coke container and fans, while Fig. 2 is an outline sketch of the same equipment. A single skip hoist serves the two units. Each container holds about 40 tons of coke, and the process is continuous. That is, as hot coke is charged from the skip hoist into the top of the container by means of an automatically revolving chute, the colder coke is drawn off at the bottom through an air-tight door. The fans operate continuously and feed the inert gases into the bottom of the container. Thus they leave at the top or hottest region. The temperature of the gases entering the boilers varies from 800 deg. F. just prior to charging, to 1,200 deg. immediately after charging, and that leaving the boiler ranges from 300 to 350 degrees.

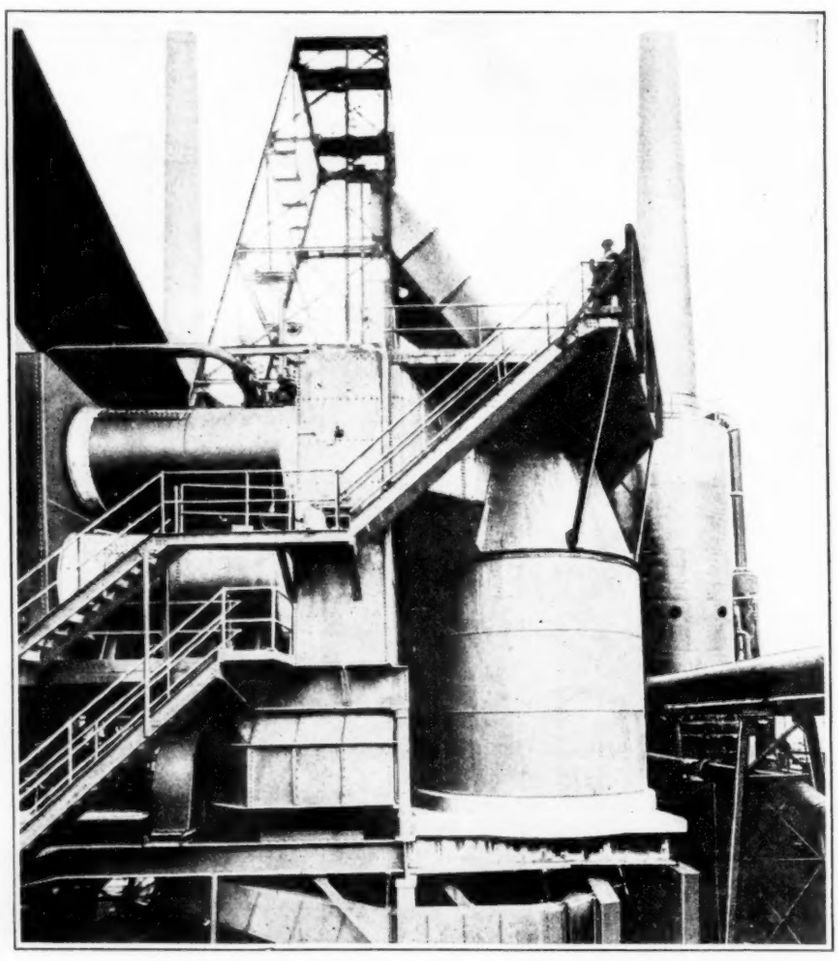


Fig. 1—Close-up view of the Rochester plant

The boilers are of the horizontal fire-tube type with 2½-in. tubes 18 ft. long, arranged in upper and lower banks. The upper bank contains 202 tubes and the lower 320. A diagram of the boiler and path of the gases is shown in Fig. 3.

Although guaranteed to handle 425 tons of coke per day, the installation has actually been handling 530 tons, which is about half the output of the Rochester gas plant; hence wet quenching is employed with the other half of the coke. Operating results over a considerable period have averaged 439 lb. of steam at 139 lb. gage pressure per 1,000 lb. of coke. Over the same period the power consumption of the fans averaged 858 kw.-hr. per day and that of the hoist 82.8 kw.-hr. Among the advantages offered in favor of the dry quenching system are elimination of the steam and vapors incident to wet quenching and the avoidance of corrosion and maintenance traceable to these vapors. On the other hand, coke from the dry quencher is smaller than wet-quenched coke and contains a larger percentage of breeze, which may or may not be desirable, according to the use

for which it is sold. In the present case, where a domestic market is served, the smaller coke saves the power and maintenance of a coke crusher. However, because of some dust it has been found necessary to sprinkle the coke prior to loading the trucks. On the other hand, when used in water-gas machines, the dry coke is said to make for better efficiency.

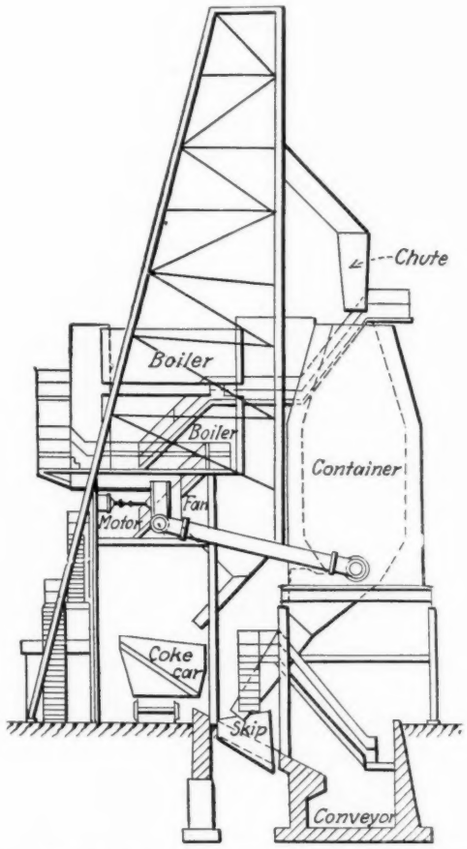


Fig. 2—Sketch of equipment shown by the photograph in Fig. 1

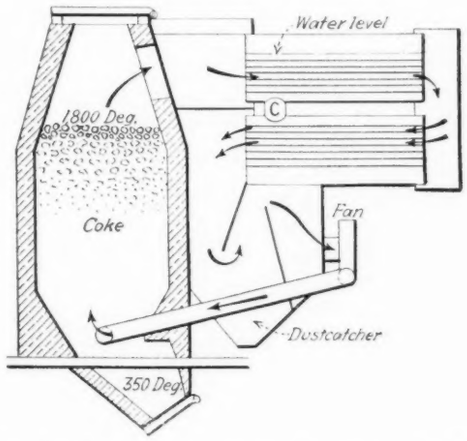


Fig. 3—Diagram of boiler and coke container, showing path of gases

Acknowledgment is made to A. M. Beebee, superintendent of the gas manufacturing department, Rochester Gas & Electric Corp., for his co-operation in making available the foregoing information.

Refrigeration Enters the Mine

IN MANY mines both the high temperature and the high humidity make the work of the miner a thing of discomfort and danger. This condition is especially true in some of the English coal mines in which the air has 100 per cent humidity and is at a considerable temperature.

In a paper read before the Institution of Mining Engineers, W. Hancock outlined the essential features of a refrigerating plant installed in the mine of the Holly Bank Coal Co., by the Hall Co.

A carbon-dioxide compressor was arranged to run by compressed air and accommodations were arranged for it, in the first tests, at a depth of 1,500 ft. The compressor was 1.75 in. in diameter and 5 in. stroke, and ran at 180 r.p.m. with the air cylinder 5.75 in. in diameter. The condenser was made of 600 ft. of $\frac{3}{4}$-in. steel tubing immersed in a tank, while the evaporator for cooling the air was made up of about the same amount of pipe. A 15-in. fan handled the air through the cooler.

It was expected that the leakage of air from any duct that could be installed would require setting the unit fairly near the face of the working wall. On account of the high moisture often encountered, as well as the high temperatures, it was expected that considerable capacity would be needed to show substantial accomplishment. All these difficulties were realized in practice, not to mention the inconveniences of working in inaccessible and restricted places below the surface. The 300 gal. of water used per day, for example, had to be carried below in tanks for these tests. The wet-bulb temperature of 81 deg. F. is the only temperature specified with regard to the first tests.

It appeared from the start that compressed air had some advantage as a source of power when equipped with heat exchangers. The cold exhaust air was used to help do the refrigerating, while the high-pressure air entering, was arranged to absorb some of the heat of compression of the carbon dioxide.

A second practical trial was given at the Pendleton Colliery, at a depth of about 8,500 ft. The place chosen to cool the air was one where men worked under the greatest discomfort, with wet- and dry-bulb readings of 100 and 85 deg. F. respectively. The arrangement of space at the face was not favorable to the arrangement of a suitable air velocity, and although the machine was placed as near it as possible and an 18-in. duct used, the effect was not positive with respect to ventilation. Apparently, effective cooling and drying of the air was accomplished, however, and it was the view of Doctor Hancock that treatment for drying, rather than cooling, was the thing that required attention.

He said it was obvious that the specific-heat capacity of air was so small that simple reduction of the dry-bulb temperature was of comparatively little use, and for effective work reduction of the moisture content was the correct line of application for refrigeration.

It seems probable that for mines that are dry throughout, the conditioning of the air may be effected at the surface or at the bottom of the downcast shaft in order solely to control the dew-point, compensation being made for high dry-bulb temperature of the air by proportionate increase in the velocity.

Refrigeration has been used in the boring of mine shafts in wet ground. Here the ground is frozen until it is self supporting and the shaft is then excavated without danger of caving.

EDITORIALS

F. R. LOW, *Editor*

Clean Evaporators

EVAPORATORS are now in use in many American power plants for the purpose of furnishing pure distilled makeup water to boilers. Where clean dry steam is not delivered from the evaporator to its condenser, it is generally due to lack of provision in the design for effective separation of water from the steam in this low-pressure region. On the other hand, where the concentration in the evaporator is allowed to become excessive, the operator must bear the blame for impurities carried over.

Another difficulty that sometimes develops is the formation of scale on the tubes. This seriously limits capacity and is difficult to remove completely even with the best cracking methods. In some designs it has proved troublesome to keep the tubes properly cleaned. It is said that in one plant it was necessary to treat the tubes with acid to free them of scale.

Boiler compounds have been used for years to keep scale soft in boilers. There is no reason why properly chosen chemicals added to the evaporator supply should not keep scale from adhering firmly to the evaporator tubes. In fact, this has been applied in one large plant that had experienced bad scaling in the evaporators, and the tube surfaces are now kept clean under all conditions. The scale is all removed as sludge by simply blowing down. The practice might well be followed more generally.

Steam to Further Supplement Niagara Power

MANY were surprised ten or twelve years ago when a large steam plant was built almost within the shadow of Niagara Falls to serve the peak load of Buffalo. This station has recently been appreciably enlarged.

Now comes the announcement that, on the Canadian side, the City of Toronto is seriously considering building a steam station to supplement the hydro power received from Niagara and to handle the peaks.

A study of local conditions and certain details concerning the proposed steam station are contained in a report completed recently by McClellan & Junkersfeld, Inc., who were retained as consulting engineers, with Professor Christie as advisory engineer, to make an investigation for the city.

Briefly, the Toronto peak demand last year was over two hundred and twenty thousand horsepower, which was supplied exclusively by the Ontario Hydro-Electric Power Commission at a cost of $20.41 per horsepower-year. The predicted annual growth in load, based on present and past conditions, is ten per cent.

Inasmuch as the peaks are of relatively short duration and, with hydro power, must be supplied over ninety miles of transmission line, the study indicated that an auxiliary steam plant for peak power, in conjunction with hydro power for base load, would furnish service to the city at a lower total cost than hydro power entirely, and in addition would provide stand-by reserve.

A plant of 230,000 kw. ultimate capacity, the first section containing two 35,000-kw. units, pulverized coal or fuel and gas from a proposed gas plant, and a combination steam-heating plant are some of the suggestions offered in the preliminary report.

The economic limitations of hydro-electric power are fairly well appreciated in engineering circles, but the general public is still prone to look upon it as synonymous with cheap power under all conditions. Recognition by municipal authorities of the steam plant as a part of the picture, in a territory now served exclusively by water power, should aid in combating this popular misconception.

Utilizing the Earth's Internal Heat

UTILIZING the heat from the sun, the energy in the tide and in the waves and the internal heat of the earth for power generation, have all attracted considerable attention and all have been experimented with, but without any material success. A few years ago Sir Charles A. Parsons aroused the interest of many engineers by advocating a plan for sinking a hole into the earth's surface to tap the internal heat source. When this suggestion has become more or less of a memory, John L. Hodgson, an English engineer, becomes the champion for a similar project which he outlined in a recent speech before the British Association for the Advancement of Science.

The proposed plan consists of sinking shafts five miles into the earth and connecting them by a tunnel. Assuming that his suggestion for making such excavations are feasible, by workmen with heatproof suits cooled with

liquid air, it seems to fall down badly as an economic proposition. If Mr. Hodgson has been quoted correctly, his plan will cost ten times that of a fuel-burning plant of equal capacity. If the operating costs of both plants are assumed to be equal, the only saving that can be credited to the terrestrial heat plant is the cost of fuel. This cost in the fuel-burning plant would have to be about twelve or fifteen times the capital cost to make utilizing the earth's heat a comparable proposition. Since in the modern steam plant the fuel cost may be only about one-half the fixed charges on the investment, the hole five miles in the earth does not look like an attractive financial undertaking.

Notwithstanding all that has been said regarding fuel saving, power projects are designed and operated on a dollar-saving basis, and under the present economic laws this is the only criterion that can govern such undertakings and have them continue to stay in existence. A system that cannot produce a commodity of the same quality as cheaply as some other is generally in a fair way to its demise.

So far the only successful plans for using the earth's internal heat for power generation is where nature has done the work of bringing this heat to the surface. The most notable of these is at Larderello, Italy, where steam is obtained from wells sunk two hundred to four hundred feet into the earth. Experiments with natural steam have have been made in this country on the Pacific Coast about seventy-five miles from San Francisco, but so far this project has not gotten beyond the experimental stage. This subject was thoroughly discussed before the American Society of Mechanical Engineers and reported in *Power,* November 24, 1925, issue. If, after nature has delivered the heat at the surface of the earth, it is found difficult to make use of it economically, the possibility of going down below the surface five miles to get it seems very much a dream, particularly when other power sources are going to waste, that could be easily utilized.

The Unit Impact Pulverizer

UNIT mills, until comparatively recently considered particularly adaptable to the small plant only, are now obtaining a foothold in some of the larger central stations. While this is resulting in the development of mills of larger capacity, little change is being made in their general construction, and this may indicate a lack of progress toward improvement in over-all efficiency.

Two years ago, on this page, *Power* pointed out the need for more comprehensive data with regard to actual efficiencies, maintenance, etc., of unit mills. This has not been forthcoming in the degree that should be expected with the development by a number of competing manufacturers of a machine whose over-all efficiency is an important factor.

A study of the designs of the various types of impact mills suggests an interesting line of thought, when considered in the light of the various principles employed. In some cases one finds a single impact, with the "coarse fines" returned to the same set of hammers. In other designs the work is done in two or more impact stages in series. Another has separate impact and attrition elements. Strangely enough, all these mills give substantially the same result, irrespective of the "modus operandi," but furthermore, they all seem to encounter the same inherent difficulty—obtaining and maintaining satisfactory pulverization. Impact only, apparently, will not powder the coal to the fineness necessary for proper firing, so various adjuncts are fitted to the mill to keep the coarse particles—immune to impact—in suspension in the mill until finally ground down by attrition.

While there is need for reliable data relative to maintenance charges in cents per ton, maintenance considered in terms of wearing parts only, is not the final answer. The cost per ton is largely affected by the power required to drive the mill *at all loads.* Is the manufacturer doing all he should toward improving the performance of the mill itself, when considered as a machine for doing a given amount of useful work efficiently? The no-load power consumed by these mills is quite out of proportion to the final work done. This is usually accounted for by eddies created in the mill, absorbing power. While these eddies may be a necessary factor in pulverization, the diversity of designs would indicate that they were just accepted as such rather than scientifically proved so.

If the coal is pulverized to a certain point by impact, and the final work done by attrition, it would appear that in the impact element eddies would be injurious rather than helpful: A sharp hammer blow with maximum shock would obviously give the best results. If attrition is the medium to be employed for the final operation, should this not be accepted and scientifically treated by itself rather than by introducing power-consuming eddies in the impact element where they do no good?

Research to establish the degree of pulverization that can be expected by impact only and the amount that remains to be done by attrition, might lead to a design having a minimum of eddy losses. The result would be a machine having an efficiency so much in excess of the present designs as to warrant a considerably higher first cost and put an entirely different light on the operating question, now considered almost entirely in terms the maintenance of wearing parts.

As the Reporter Sees It

DESCRIBING a plant to generate steam at 350 lb. per sq.in. and 725 deg. F., a contemporary daily discusses the awesome nature of this hot fluid.

"The effect of this steam on the human body would be the same as that of a buzz saw, that is, if the finger were placed over a steam vent it would drop off as if cut off by a buzz saw. At this temperature, the steam is entirely invisible."

Why not employ the steam direct in a sawmill?

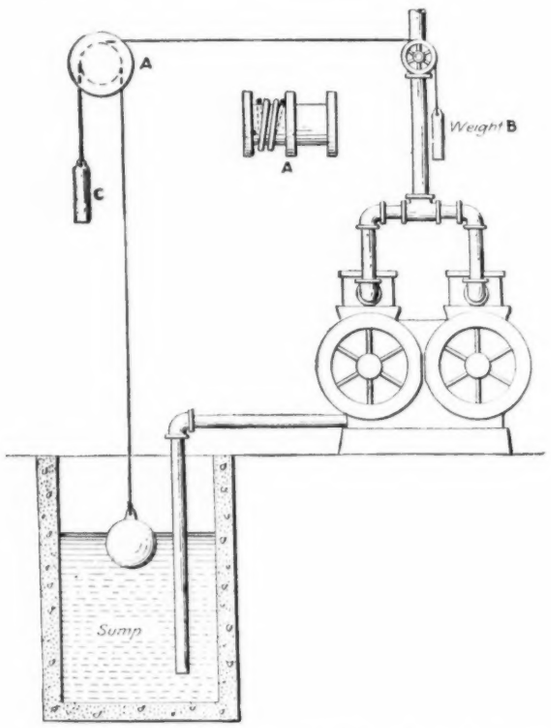
IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Improvised Sump Pump Control

AN ARRANGEMENT for the automatic control of water level in a sump is shown in the illustration. The engine was in a basement into which considerable water seeped. Frequently, the engineer would forget to attend to the sump pump, and the sump would overflow, making a disagreeable mess.

The wheel on the throttle valve was removed and one with a grooved rim substituted. In line with the throttle wheel a double spool pulley was arranged on the same shaft. A cord was secured to one of the pulleys and then run over the grooved pulley of the throttle valve a complete turn to give sufficient friction to turn the valve stem. At the end of the cord a weight was attached to keep the cord tight on the pulley.



Float control applied to standard globe valve on steam line to pump

As the double pulley *A* was directly above the sump, it was only necessary to drop a cord from the second half of the pulley through the flooring above the sump. Attached to the other end of the cord was a float. The necessity for a double pulley was to get the correct direction of travel so that the steam valve on the steam pipe to the pump would be opened as the water level increased. The float must be heavier than the weight *C* in order to close the valve when the water level has been reduced. As the float rises, the weight *C* overcomes the weight *B*, as it is heavier, and the steam valve is opened, thus starting the pump.

The main objection to this arrangement is the cutting of the valve disk and seat, due to the wiredrawing of the steam.

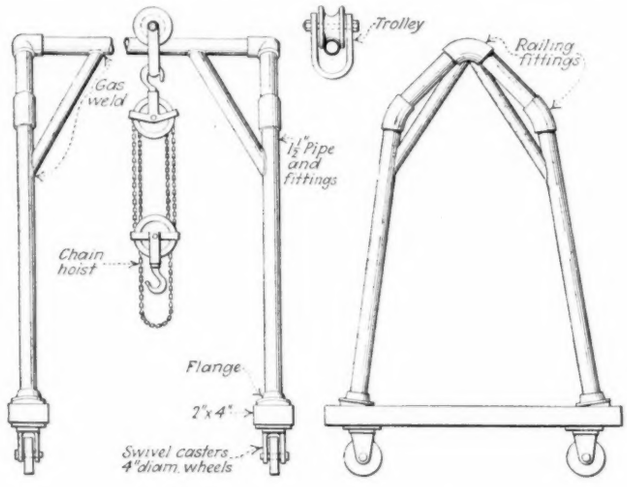
D. W. CLARK.

Columbus, Ga.

A Handy Floor Crane for the Power Plant

REPAIRS in power plants to motors, small generators and turbines frequently require a chain hoist or other lifting tackle, and sometimes a great deal of rigging is necessary to support the hoist or a man may have to make a high climb just to find a place to attach the hoist over the job.

A floor crane made from pipe and fittings, as shown in the illustration, will find many uses around the power plant. It is designed with the idea of straddling the job and is provided with a roll carrier for attaching the hoist. Four ball-bearing swivel casters attached to 2x4-in. timbers which support the legs of the crane make it easy to move about.



Floor crane made from pipe and fittings

The dimensions of the height and span can be made to suit conditions, with the idea of providing sufficient capacity for the heaviest job that is likely to be handled. The material used is mostly 1½-in. or 2-in. pipe and fittings with 2x4-in. wood bases for supporting the legs.

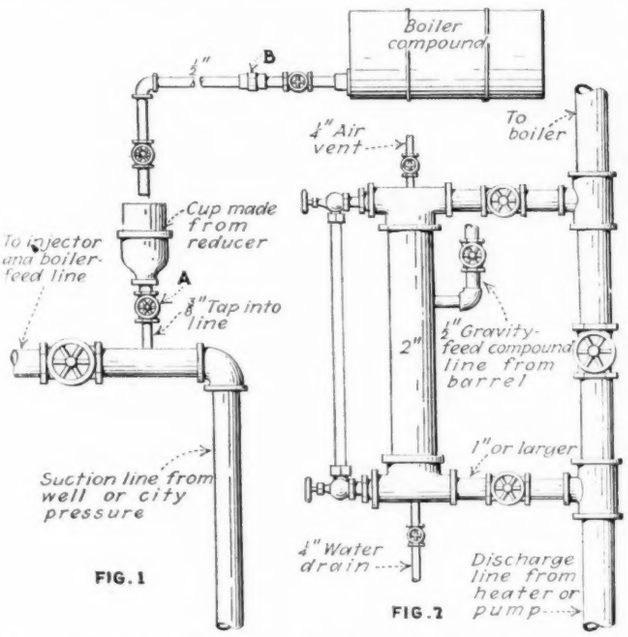
Syracuse, N. Y. H. L. WHEELER.

Simplifying the Feeding of Boiler Compound

THE accompanying illustration shows two simple and practical methods of feeding boiler compound. As shown in Fig. 1, the injector suction line is tapped for ⅜-in. pipe, into which is screwed a short nipple and a cup made from pipe fittings. The cup should be just large enough to permit the feeding of the proper quantity of compound.

The barrel of compound can be placed anywhere in the boiler room high enough to give a gravity feed to the feed-pump suction pipe.

For operating, the valve *A* below the cup being closed, the cup is filled with compound, the injector is started



Figs. 1 and 2—Methods of feeding compound on suction and discharge side of injector or feed pump

and valve *A* is then opened and the suction draws the compound from the cup.

When the cup is empty, the valve *A* must be closed. This operation can probably be simplified by placing a ball check in the cup, which would seal the opening when the cup is empty.

This installation can be used equally well where an injector well is used or where the injector is connected directly to the city pressure. The important point in either case is to have the injector in operation before opening the valve *A* beneath the cup.

The installation is simple, and if a union is placed between the two valves in the ½-in. line, as at *B*, it will facilitate the removing and replacing of the barrel or tank of compound.

Another simple installation is shown in Fig. 2. The discharge line from the boiler-feed pump is bypassed as shown in the sketch. A few strokes of the pump will force the compound into the boiler. With this arrangement the compound is also fed into the container by gravity, as in Fig. 1. The container in the bypass should be of proper size, so it can be filled to the top of the gage glass and the air excluded. The size, of course, depends on the amount of compound to be fed.

A 2-in. nipple 12 in. long contains 37.62 cu.in. and will hold slightly less than 1½ pints; with fittings as shown, it will hold about a quart. The arrangement shown in Fig. 2 should be installed between the feed-water heater and the boiler. This arrangement is, of course, the more practical, but entails a slightly larger expense than that shown in Fig. 1.

A. MAIER.

Monterey, Calif.

Condenser Performance Chart

TO REPRESENT a steam condenser performance, I have constructed the chart illustrated herewith.

The temperature of the circulating inlet and discharge water are taken as the abscissa, the performance as the ordinate, and the temperature of the steam corresponding to the vacuum is placed on the top horizontal line expressing the temperature corresponding to the same scale as the abscissa. The performance of any condenser under operation can then be found by drawing a line from the data gained from the vacuum gage and from thermometers. For instance: Temperature of circulating inlet water, 50 deg. F.; temperature circulating discharge water, 60 deg.; vacuum 29.3 in. or 69.5 deg.

Now, draw a line connecting 50 deg. and 29.3 in. or 69.5 deg. and a horizontal line where the diagonal line intersects the 60-deg. line, the performance being indi-

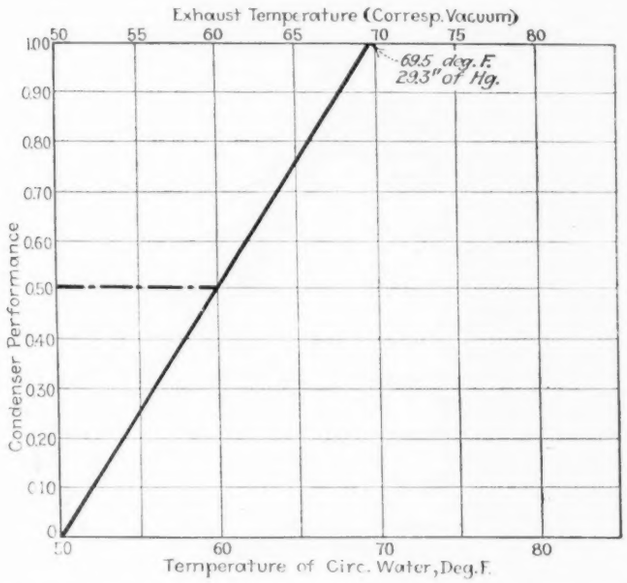


Chart showing condenser performance with water and vacuum temperatures ranging from 50 to 85 degrees

cated in the left-hand column, which in this case is 0.51.

As explained, the principle of the construction of the chart is simple.

$$\text{Performance of condenser} = \frac{\text{Disch. Temp.} - \text{Circ. inlet temp.}}{\text{Vacuum temp.} - \text{Circ. inlet temp.}}$$

so that, for ideal performance, or *1*, the vacuum temperature should be equal to the discharge temperature; then any other performance is included in the series of conditions presented.

The chart is useful in determining how to get the best performance and also a reasonable vacuum, depending on the conditions.

Y. UYEMURA.

Tokio, Japan.

COMMENTS *from* READERS

Automatic Boiler Blowdown in Proportion to Moisture Content of Steam

THE discussion of "Automatic Boiler Blowdowns in Proportion to Moisture Content of Steam" in the July 5 issue by J. W. Hughes was of much interest.

There are several points, however, that are contrary to previous experience and are therefore worth while discussing at this stage, especially in view of the fact that steam purification in these days with high ratings is of paramount importance. It is therefore in line to bring out the best points known to practice as concerns this particular problem.

The first point of comment is brought about by the statement given at the bottom of column 1, page 14: "It is comparatively simple to build a device that will separate slugs of water from steam, but it is another problem entirely to build a device that will separate the

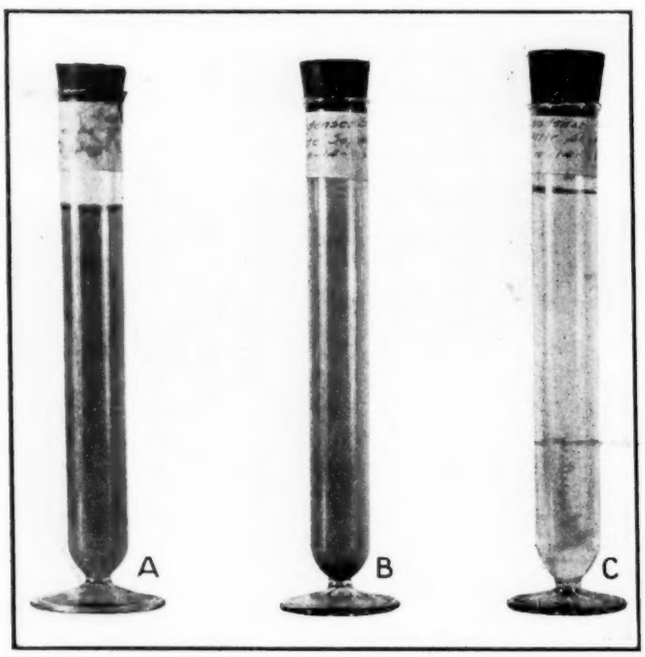


Fig. 1—Samples of boiler water and condensed steam

A—Sample of boiler water; *B*—sample of condensed steam before passing through separator; *C*—sample of condensed steam after passing through separator.

finely divided moisture of 99.5 per cent steam. In this connection it is noted that a steam purifier is distinguished from the ordinary separator in that the inference is made that a separator is not capable of reducing moisture content in the steam to a point below ½ of 1 per cent. The following data are therefore submitted, which indicate a recent test on a receiver separator (purifier type) and as illustrated and described on page 710 of the May 10 issue. It will be noticed that the moisture content of the steam leaving this separator is much below ½ of 1 per cent.

In addition to this it will be noted not only that the separator is efficient in giving a good quality of steam but that it is also capable of handling large quantities of moisture content in the incoming steam. Subsequent

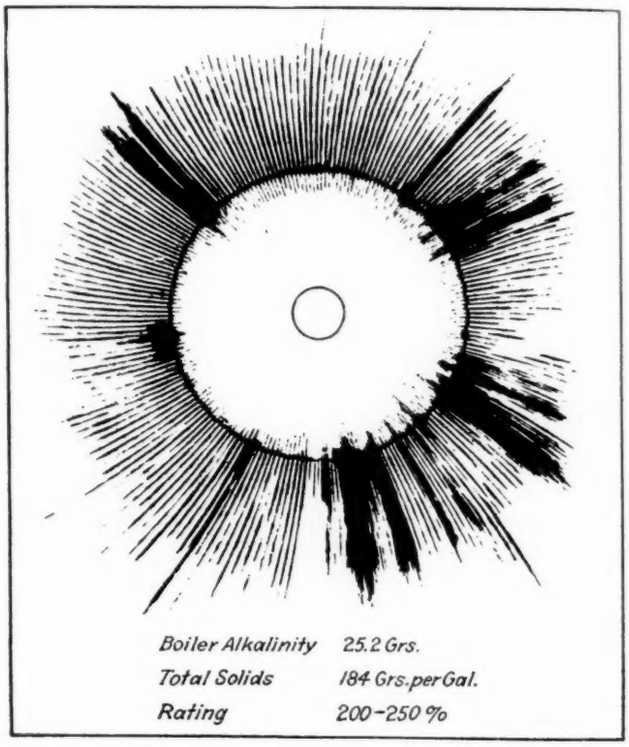


Fig. 2—Reproduction of chart from trap discharge showing when priming is most severe

tests indicated that a much better moisture content might be produced comparable to the best guarantees made for the usual steam purifying equipment. Experience also shows that it is rather difficult to determine moisture content correctly below 0.2 of 1 per cent. In other words, the limit of error in a throttling calorimeter might properly be placed at 0.2 of 1 per cent of moisture.

Condensed steam tests on separators of this type indicated a high degree of separation and the high capacity of the separator is illustrated by Fig. 1, which shows a sample of boiler water and a sample of condensed steam before and after the separator respectively.

At this period measurement of the trap discharge tests indicated that as much as 40 per cent of moisture was being separated from the steam. It is because of these tests and the unusual performance of this type of separator that exception is taken to Mr. Hughes' inference that the ordinary baffle type of separator will not work as efficiently as a steam purifier.

The method of controlling the blowdowns automatically, as described by Mr. Hughes, proved of much interest, but in practice might be subject to some criticism. It appears that the reason for the auxiliary blowdown is chiefly the generation of steam of a quality that is at all times within the possibilities of purification. In other words, the primary purpose of the auxiliary blowdown is to keep the priming to such a point that the capacity of the steam purifier is never exceeded. This is a good procedure with many purifiers that have a limiting capacity.

There are, however, possibilities where this procedure would not be practical. In cases where, for instance, the boiler is run at low ratings, as, say, during the night, and the concentrations are allowed to build up to a high point. If the boiler is in this condition and a

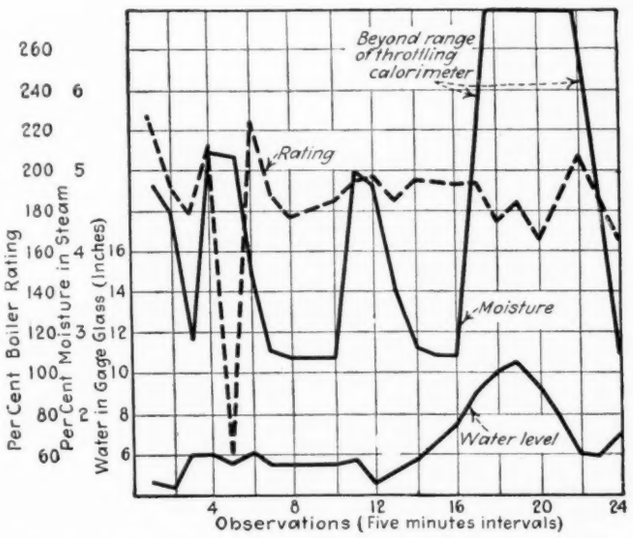


Fig. 3—Chart shows variations in water level and per cent moisture in steam

sudden increase in load takes place, the separator will become flooded before the automatic blowdown has had the chance to relieve the concentrations down to the desirable limit.

Further study of the problem suggests that if a steam separator or steam purifier could be designed with unlimited capacity, then the entire blowdown could be taken through the purifier without the use of the auxiliary blowoff line. Because of the high capacity of the separator previously referred to, it has been used successfully for this purpose. In this connection it was found that the capacity of the separator is limited only by the capacity of the trap draining it. In this way a closer regulation of concentrations may be had without the use of additional automatic blowdown valves and make the entire process automatic and simple.

A chart taken from the trap discharge of such a separator is shown in Fig. 2. This illustrates qualitatively when priming is most severe. Calorimeter tests made during discharge of this character indicate practically dry steam.

Another advantage of the external receiver type of separator is that it would take care of a high water condition that cannot be handled by internal devices. A high water condition is not infrequent and many times not due to faulty operation. I have been on tests where the boilers have been operated at comparatively high ratings. With the type of boiler in use, the normal water level was maintained, but with a drop off of load the level in the gage glass dropped, which resulted in automatic feeding of the feed water. When the load picked up again, which was quite rapidly, the water filled the gage glass, resulting in violent priming over an extended period, as indicated by the chart, Fig. 3. Such a condition, it will be noticed, extends over rather lengthy periods and may occur even when the water is not susceptible to priming so that ample capacity of steam purification is necessary in order to prevent excessive moisture from carrying over into the steam lines even though the concentrations are below the priming point.

It is therefore evident that automatic control of blowdowns and best possible insurance against moisture in steam at all times both from high water and from priming, make it necessary that a high-capacity separator be used. It is because of the high capacity and efficiency of the receiver type of separator that I have been prompted to make these comments.

It would be interesting to have data from a plant where Mr. Hughes' method of automatic blowdown has been in practical operation.

C. E. Joos,
Philadelphia, Pa. Cochrane Corporation.

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Answers to "What Do You Know?" Questions

IN THE August 23 issue the answers to Questions 9 and 10 in the "What Do You Know?" column could have been amplified. The answer to Question 9 in regard to cutting gage glass is sufficient provided ordinary tubing is used. However, in many cases Pyrex glass tubing is used for gage glasses. The method of cutting ordinary tubing is ineffective for Pyrex, as I had occasion to try it at one time. Although it was difficult to do, a notch was filed all around the circumference. A flame of a small blow-torch was then applied at the scratched portion, and when sufficiently heated the tubing was firmly grasped and bumped gently against the corner of the work bench. The break took place $\frac{1}{4}$-in. from the heated and scratched portion. Effective cutting of such glass is done by wrapping thin resistance wire around the tubing where it is desired to have it cut, being careful not to have the wires touch, and then heating the wire to incandescence by means of an electric current. The current is then shut off, the wire removed and a drop of water placed on the heated portion of the tubing. A gentle tap against the work bench gives a clean break at the place where the wire has been wrapped. This method has been found to be effective every time I have had occasion to cut Pyrex tubing, producing a clean and a neat break in each case.

With regard to Question 10 about the power consumed by a fan in handling hot or cold air in connection with heating coils, it might have been stated that additional saving in power is realized by placing the fan ahead of the coils, owing to a smaller fan being required. In such installations some of the kinetic energy of the air is utilized in overcoming the resistance of the coils instead of being wasted, as most of it is if the fan is placed back of the coils. This has been realized and applied in the present Franklin automobile. The older models all had large Sirocco fans placed behind the engines, wasting all the kinetic energy of the air on the discharge ends. The present models have much smaller fans placed in front of the engines, thus utilizing the power available from

the discharge in a form of kinetic energy to overcome the resistance in passing over the finned cylinder surface. It is well known that the cooling is equally as effective, if not better, in the present models than by the older ones, besides much less power is used. The same principles apply to fans with heating coils.

State College, Pa. A. J. NICHOLAS.

* * * *

Wet and Dry Compression

REFERRING to the editorial in the April 19 issue of *Power,* entitled "Why Not Follow Theory?" I believe the subject of wet and dry compression in ammonia compressors could stand a good airing.

There are in my opinion two ways of producing wet compression. One is to pull over enough liquor from the evaporating coils to keep the temperature of compression down, and the other is to inject liquor into the compressor during the compression stroke for the same purpose. The former method produces an indicator diagram showing a lower consumption of power, but the volumetric efficiency of the compressor is greatly impaired. I have not yet been able to determine the merits of the second method for lack of such a compressor or for lack of time to construct injectors. Operating dry, however, shows the compressor to be consuming considerably more power, but its efficiency is greatly increased.

Perhaps an engineer will come forward with some diagram taken from a compressor using injection. It would be interesting to see how closely this injection can be controlled to produce a diagram showing minimum power consumption and a high volumetric efficiency.

There is no doubt that a compressor pulling over large quantities of liquor from the suction line is working uneconomically, for the re-expansion of some of this liquor in the cylinder reduces its volumetric efficiency.

If, on the other hand, the expansion valves are pinched down to a point where the gas returns dry, or about 100 per cent in quality, to the compressor, the capacity of the evaporating coils will be reduced. This condition arises from the fact that some or all of the coils are not receiving all the liquor of which they are capable, with the result that capacity, or evaporating area, is lost. The gases might even come overly superheated, and this would result in high discharge temperatures, particularly if the back pressure was low. Finding a happy medium between these two extremes is by no means easy when operating about 200 expansion valves, as in the case in the plant under my charge. Trying to find the particular valves that are open too much wears out the men. There exists the opinion among some engineers that high discharge temperatures are accompanied by decomposition of ammonia, thereby fouling the condensers with inert gases and directly causing the loss of the ammonia charge. The wet advocates also argue that the suction gas, when coming in contact with the hot cylinder walls of the compressor, will immediately take on heat and expand, causing even a greater loss of volumetric efficiency than when the compressor is working cold. They further substantiate their claims by pointing out the additional pressure rise, due to the heat of compression and the power required to overcome this.

The "drys" for their part say that the additional volumetric efficiency obtained more than offsets the additional power required. Further, a hot compressor will successfully operate with metallic packing reducing rod friction to a minimum, while a cold rod will not only consume power, but will be the cause of considerable loss of ammonia. They also claim that ammonia, if reasonably pure, will not decompose at temperatures under 300 deg. F.

Thus we have a variety of conflicting opinions which I am sure refrigerating engineers would like to see discussed by some authority in these columns. If I am correct in my views on dry compression, the discussion should bring about a marked economy in plants that are still operating wet, always provided these plants are remodeled to operate dry.

Of course all modern plants follow dry compression, but there are many old ones operating with wet gas.

W. G. SCHMIDT.

Buenos Aires, Argentine, S. A.

* * * *

The High Cost of Cheap Oil-Engine Operators

THE articles by A. W. Newell and W. P. Gibson, which appeared in the June 28 and Aug. 9 issues respectively, on "The High Cost of Cheap Oil-Engine Operators," are in direct accord with my opinion regarding oil-engine troubles. During the last eight years as traveling engineer for two of the largest oil-engine manufacturers in this country, I have found that nine-tenths of oil-engine troubles are due to faulty operation by incompetent operators. It is indeed strange why the owner of an oil-engine plant, representing an investment of from $20,000 to $100,000 or more, will entrust it to a man whom he wouldn't allow to drive a $2,000 automobile across the street. However, this is frequently the case.

Because of the heavy construction and apparent simplicity of a well-made oil engine, many people believe that it needs no attention whatever and can be operated by anyone. The result is, we find the oil engine in many cases struggling under the most trying conditions in the hands of the poorest kind of operators. When trouble develops, regardless of what the condition may be, the operator is seldom questioned concerning the situation and often never taken into consideration at all, but the engine is almost always sure to be condemned and the manufacturer severely criticized.

I was once called upon to locate trouble on a four-cylinder two-stroke-cycle oil-engine of the low-pressure type, direct connected to an alternating-current generator. The customer's complaint was that he had bought an inferior engine which would not develop its rated horsepower. His operator reported that cylinders Nos. 1, 2 and 4 ran abnormally hot under load, while No. 3 was always "nice and cool." Upon investigation I found No. 3 cylinder dead, owing to a broken valve in the corresponding fuel-injection pump.

It seems ridiculous that the operator in charge of an oil engine of this size was absolutely ignorant of the fact that the cold cylinder was cut out and the engine was trying to carry the load on three cylinders. This is one of the many similar instances I have encountered where the oil engine has been condemned on account of an incompetent operator. Had this engine been in charge of a good engineer, the trouble would have been immediately located and checked, thus saving much unnecessary trouble and many expensive delays.

Anderson, Ind. D. DESLAURIERS.

Bethlehem Torque Amplifier

A device for controlling accurately with a small expenditure of energy various types of mechanical motions

THE Bethlehem mechanical torque amplifier (Nieman patents) recently developed by the Bethlehem Steel Co., Bethlehem, Pa., is a mechanism provided with a control shaft at one end and a work shaft at the other, the control shaft requiring only a feeble torque to operate it in either direction, while the work shaft yields a torque of sufficient amount to accomplish any purpose desired, at the same time accurately following the control shaft in all its angular movements. Its broad purpose is to perform the functions of an electrical or hydraulic servo-motor, but so different are its operating characteristics that it should be considered as an entirely new type of control apparatus.

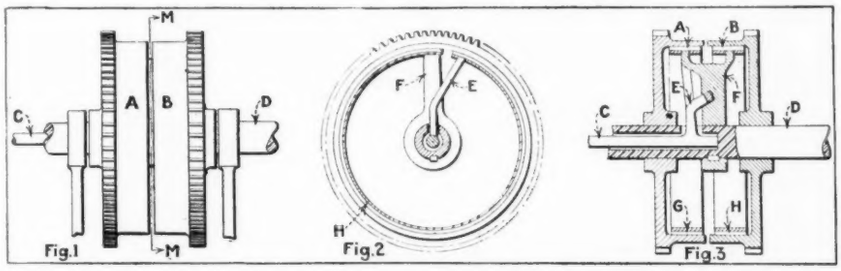


Fig. 1—Simple form of torque amplifier

Fig. 2—Section M-M through Fig. 1

Fig. 3—Longitudinal section through Fig. 1

There are three elements to the torque amplifier: "work shaft," "control shaft" and "drive shaft." The drive shaft is driven by any outside source of power, such as an electric motor, and revolves continuously in one direction, a single motor being capable of operating a number of different amplifiers whose operation is entirely independent. The control shaft is actuated by any mechanical or manual control means, or by such weak forces as can be delivered through electrical recording instruments or telemetric transmission systems. The work shaft is directly coupled to the work to be done, as for instance the elevating or training gears of a gun, a ship's rudder or the steering wheel of an automobile. The control shaft can be freely revolved in either direction, with only a small amount of effort; the work shaft maintains at all times its angular synchronism with the control shaft, and in addition exerts a heavy torque to overcome outside resistance.

Fundamentally, the torque amplifier consists of two oppositely rotating drums provided with friction bands which may be brought into contact with the drums through actuation of the control shaft, this frictional contact causing the friction bands to exert pressure on the work shaft. The force applied to the control shaft is thus enhanced, or amplified, when it reaches the work shaft by the extent to which the bands are urged forward because of their frictional contact with the rotating drums.

In its simplest form the amplifier is shown in Fig. 1. Two oppositely rotating drums *A*, *B*, are driven by a motor, not shown, through gears integral with the respective drums; *C* is the control shaft and *D* the work shaft. Fig. 2 is a section through Fig. 1 at the line *M-M* and viewed in the direction of the arrows; while Fig. 3 is a longitudinal section through both drums. The control shaft *C* is concentric with work shaft *D* and is supported by a socket bearing in *D*. Integral with *C* is the forked control arm *E* which passes through a hole in the side of hollow shaft *D*, the size of this hole being sufficient for clearance and to allow a considerable angular movement of *C* in relation to *D*. Keyed to *D* is work arm *F*, also forked.

The friction bands *G* and *H* fit inside the drums *A* and *B*, respectively. These bands have sockets at each end, one socket of each band engaging with a stud on the work arm *F*, the socket at the other end of each band engaging with the respective ends of the control arm *E*. The bands are disposed in opposite directions in the two drums so that in each drum the band extends from the control arm around to the work arm in the direction of rotation of that drum. It follows that if the control arm is revolved in a given direction it will expand and tighten the band which lies in the drum rotating in the direction of the movement given to the control shaft, at the same time contracting and loosening the band in the opposite drum; therefore, the work arm, because of the frictional engagement of the band in one of the drums, is pushed around by that band in the direction of the drum's rotation.

The action of the work arm in following the movements of the control arm can be understood from the following consideration: Observing only drum *B*, as shown in Fig. 2, if the control arm *E* is moved to the right by an infinitesimal amount, the band which was originally barely in contact with the drum, is now put into frictional engagement with it. This forces the end of the work arm also to the right, the movement of the work arm in this direction tending to loosen the band, so that when the work arm has followed the control arm through exactly the same angle, the band again reaches the condition of being barely in contact with the drum. If the movement of the control arm is a continuous one to the right, then the work arm follows continuously so that the tape is always maintained in bare frictional contact with the drum.

For purposes where an amplification of 40 to 1 is not sufficient, the desired degree of amplification might be obtained by using a number of amplifiers in series, the work shaft of the first being connected to the control shaft of the second amplifier, and so on, the work shaft of the final amplifier performing the required work.

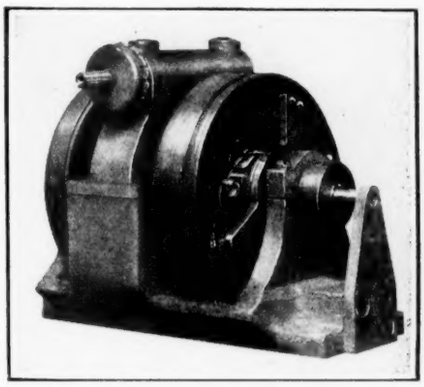


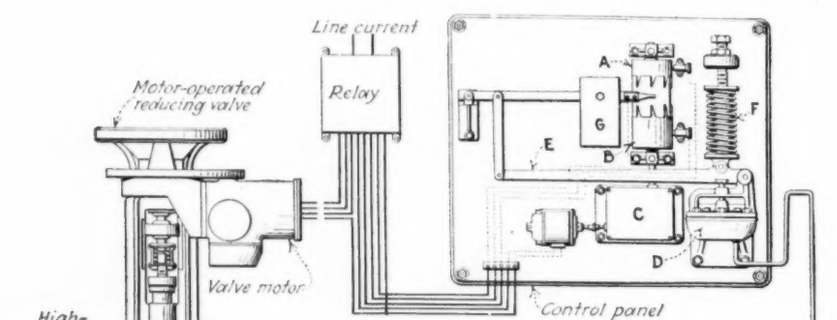
Fig. 4—Light-duty type service amplifier

Possible uses of the torque amplifier include such a range as automobile and ship steering, gun turning, train, switch and signal control, control of steam systems, running of tower clocks, operating valves, opening or revolving doors, metering devices, governors, various machine-tool mechanisms, etc.

New and Improved EQUIPMENT

Schutte & Koerting "Helpbringer" Control for Motor - Operated Reducing Valves

TO MAKE it possible to locate the control mechanism of its relay-controlled valves some distance from the point at which the reduced pressure is to be controlled, the Schutte & Koerting Co. has recently brought out the "Helpbringer" control illustrated herewith.



Motor-operated reducing valve with relay and control panel

The control consists essentially of a pair of insulated contact drums *A* and *B* mounted on a vertical shaft and driven through the reducing gear *C* by a small high-speed motor which operates continuously. The drums turn slowly, about 2 r.p.m. A small pipe connects the low-pressure steam main to the diaphragm chamber *D* on the control panel, and variations in the pressure in the main are transmitted to the diaphragm and the compound beam *E* riding on the diaphragm and pivoted on knife-edges. A compensating spring *F* is used to balance excess pressure, and a sliding weight *G* permits adjustment of the beam. The floating end of the upper member of the beam carries an insulated finger that makes contact with the revolving drums. Each drum is fitted with a stationary-brush contact connected through relays to the main valve motor. When the floating lever makes contact with the points on the upper or lower drum, due to increase or decrease in the pressure in the main, there is a make-and-break action that produces intermittent applications of current to the motor on the main valve, closing or opening the valve to reduce or increase the flow of high-pressure steam until the pressure in the main has been re-established.

A slight variation in reduced pressure causes immediate operation of the main-valve motor, but this operation is only momentary and just enough to open or close the valve a slight amount. The drums revolve so slowly that the main valve-motor circuit is broken part of the time and the pressure in the main has a chance to re-establish itself. The object of the intermittent action is to duplicate as nearly as possible the steps that would normally be made in manually controlling a reducing valve; in other words, the main valve would be opened or closed a slight amount and the operator would observe the effect on the reduced pressure, further opening or closing being made only if necessary. This feature tends to eliminate "hunting" action.

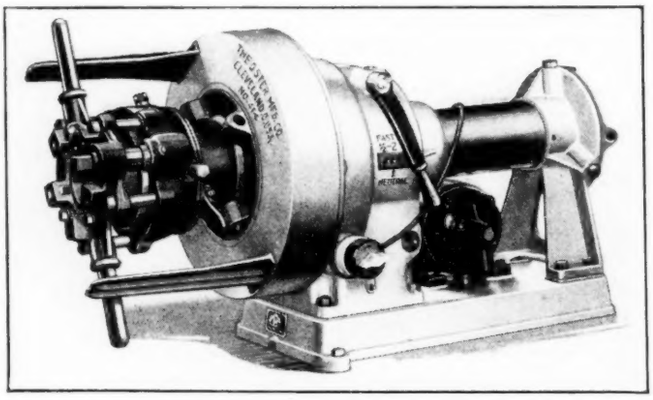
The valves used with this control are available in globe, angle and offset bodies. Limit switches in the electrical circuit are used to safeguard the valve against damage from jamming the disk on the seat. An additional safeguard is a flexible coupling on the spindle.

Oster No. 414 Power Boy

THE Oster Co., Cleveland, Ohio, has recently extended its line of pipe-threading machines by the addition of the 4-in. portable pipe threader shown in the illustration.

The new machine, which is known as the No. 414 Oster Power Boy, is designed to handle all sizes of pipe from ½- to 4-in. and to drive geared die stocks from 4½- to 12-in. by means of an auxiliary drive shaft. In addition, any square-end or roller-type pipe cutter of 2-in. capacity can also be driven. The driving power is furnished by a ½-hp. universal motor and a two-speed transmission is also used. A gear-shift lever on the side of the machine permits ready change of speeds to suit the various sizes of pipe.

The pipe to be threaded is held stationary in a three-jaw self-centering chuck, and the pipe tools are turned by the driving arms. Self-centering universal guides are also provided in the rear of the machine to assist the front chuck in centering long lengths of pipe.



Portable pipe threader for sizes up to 4-inch

RECENT PUBLICATIONS

STANDARDS OF THE HYDRAULIC SOCIETY, Fourth Edition, 80 pp. 8½ in. x 11 in. Price 50 cents.

The standards recommended by The Hydraulic Society are published as a service to both manufacturer and users of reciprocating and centrifugal pumps. It contains definitions, terms and practices relating to their use and manufacture as well as commercial and technical engineering data.

Standard methods of pump testing are given in extracts from the A.S.M.E. Power Test Code on reciprocating and centrifugal pumps. Included are instructions on the installation and operation of both types of pumps.

METHODS OF THE CHEMISTS OF THE UNITED STATES STEEL CORPORATION FOR THE SAMPLING AND ANALYSIS OF GASES. Published and sold by the Carnegie Steel Company, Bureau of Instruction, Pittsburgh. Paper; 6 x 9 inches; 187 pages; 25 illustrations. Price, $2.

This book, the result of more than two years' work of a committee composed of the chief chemists of the subsidiary companies of the United States Steel Corporation, is designed to serve the needs of the chemists of this company. It nevertheless contains much of interest to those who have but a limited knowledge of chemistry. The book is divided into four parts dealing with different phases of gas work as follows:

Part I is devoted to apparatus, reagents and absorbing solutions. In it are found a discussion of the sources of error in gas analysis, a detailed description of the construction, operation and care of the new apparatus, and a section on the preparation and properties of reagents and solutions used in gas analysis. This part of the book probably contains more of interest to the power-plant man than other portions of the book.

Part II gives a detailed direction for the sampling and analysis of flue and chimney gases, blast-furnace gas, producer gas, by-product coke-oven gas, coal gas, flue gas, natural gas, mixtures of natural and coke-oven gas, and mine air. A special portable apparatus of the Orsat type for flue-gas analysis is described.

Part III deals with the miscellaneous determinations that cannot be made with the regular gas analysis apparatus.

Part IV deals with the measurement of gases, calculation of gas volumes under different conditions, and a number of problems presented by the combustion of gases. This is followed by an appendix in which are some twelve tables that give the specific gravity, the weight per cubic foot, B.t.u. values, and the specific heat of gases under the standard conditions selected, the properties of water vapor, practice for the correction of observed calorimeter readings and a long list of conversion factors.

COMMERCIAL YEAR BOOK — Volume I —A statistical review of business and industrial conditions in the United States and for seventy foreign countries during and prior to 1926 — Bureau of Foreign and Domestic Commerce, Department of Commerce —Superintendent of Documents, Government Printing Office, Washington, D.C. Cloth 6x9 inches, pp. 675. Price $1 per volume.

As a reflection of the greatly increased sale of the last issue of this Year Book, the present issue is in two volumes. Vol. I contains detailed information concerning business conditions in the United States, while Vol. II, yet to be issued, contains similar though in somewhat less detail, for almost seventy foreign countries and for the non-contiguous territories of the United States.

Production and distribution in the United States both established new high records in 1926. Business has been expanding ever since the middle of 1922, and the great activity during the past year was distributed to almost all lines of production. Manufacturing output rose to a new high level; mineral production showed an even greater expansion, and railroad traffic was larger than any previous year. Crop production also increased, but farm prices were lower than in 1925. The basic reason for the general expansion of business has been the increasing efficiency of both industry and trade.

The Year Book covers the operations of the various branches of business and industry in great detail, and should be a part of every executive's library.

EXPORTS, IMPORTS AND CONCESSIONS OF THE SOVIET UNION. Here is a book, printed in Russia, that is particularly remarkable in that it has been printed in four languages with the object of providing foreign business men with an idea as to foreign trade and concession affairs in the Soviet Union.

In the general section are articles designed to provide an idea on the development of the monetary system of the Union, the organization and nature of its foreign trade, the financing of its imports and exports. There are sections devoted to exports, to imports, to concession enterprises and to general information.

In the import section, data are provided for the foreign exporter on the commodities of which the Union is in need.

The volume is obtainable from the Amtorg Trading Corp., 165 Broadway, New York City.

PUMPING CHICAGO'S WATER—Seventy five years of water-works history are epitomized in the history of the Chicago water-works system, as told in a leaflet issued by the De Laval Steam Turbine Co. in connection with the annual meeting at Chicago of the American Water Works Association.

Beginning with a vertical, single-acting, condensing steam engine of eight million gallons daily capacity in 1853, the system has grown until it now approximates a daily capacity of one billion gallons per day, of which more than one-half is supplied by fourteen De Laval centrifugal pumps, all except four of which are driven by De Laval geared turbines. The steadily improving economy of this type of pumping unit is indicated by the fact that two 60 million gallon per day units which were tested in 1922 developed on test a duty of 154.36 million foot-pounds per thousand pounds of steam, while two similar units tested in 1924 developed 172 million foot-pounds per thousand pounds of steam, and two units of the same capacity tested in 1926 gave 191.3 million foot-pounds per thousand pounds of steam. All these units received steam at a pressure of 175 lb. per square inch, with 150 deg. F. superheat. The four 75 million gallons per day De Laval geared turbine units now being built for the William Hale Thompson Station are guaranteed to develop duties of 203,500,000 ft.-lb. per thousand pounds of steam. These very high duties, together with the small weight and size of the geared-turbine-driven pump and the consequent small cost of buildings and foundations, have caused it to sweep aside almost entirely the triple-expansion reciprocating pump, which for so many years held the field unchallenged.

PRESS BULLETIN SERIES NO. 10, ILLINOIS PETROLEUM, will soon be issued from the press by the State Geological Survey at Urbana, Illinois. In this issue of *Illinois Petroleum* the structure of the Centralia and Sandoval oil fields, in parts of Marion, Clinton and Washington counties, Illinois, is described in detail with a view to establishing a relation between it and oil production. The paper is accompanied by structure maps and cross sections. Attention is also called in this publication to a new producing horizon in Wabash County, which has just recently been discovered by deep drilling. As long as copies are available, they may be secured for 25 cents by addressing the Chief, State Geological Survey, Urbana, Illinois.

STEAMBOAT INSPECTION RULES, RIVERS—The Department of Commerce, Steamboat Inspection Service, has published the edition of March 23, 1927, containing steamboat inspection rules and regulations for rivers as amended by the board meeting of Jan., 1927, and by the executive committee of the board at the meeting of Oct. 19 and 20, 1926. The edition also contains a list of all approved vessel equipments.

NEWS *of the* FIELD

Earth's Heat Better, Cheaper Power of Future

Tapping the interior of the earth for heat, and as a result power, will ultimately place the burning of coal among antiquated practices of a primitive industrial civilization, according to the somewhat revolutionary proposal set forth by John L. Hodgson, who addressed a meeting of the British Association for the Advancement of Science in session at Leeds, England, September 2.

Mr. Hodgson has estimated that the heat content of the earth is approximately thirty-one million times greater than that stored in the earth's available coal. It is necessary, he stated, to find an economical method of boring one of two types of holes, one of which would be thirty miles deep, the other five, for it is not the scientist's plan to make use of hot geysers or to "harness volcanos," although these means are followed to a limited extent in California, Iceland and Italy. It is proposed rather to pierce the earth's crust and let the hot rock at a great depth turn water into steam. At a depth of twenty miles or more a temperature of at least 1,600 deg. F. prevails, he said. Here lies one "heat mine" of the future.

Eroding Aluminum Alloy

The thirty-mile hole proposed by Mr. Hodgson would be only a foot in diameter and is intended to reach regions of very high temperature. It would be sunk by methods similar to those adopted in California at Big Sulphur Creek, where hot geysers were tapped. Human labor is out of the question, because of the intense heat. The hole would be made by an eroding aluminum alloy melted by electricity and circulated by heated compressed air. An alloy to offset a rock pressure of more than 250,000 lb. to the square inch would be necessary.

Such a hole would produce more than 4,000 hp., even if the heat were used with only 20 per cent efficiency. A boiler to utilize the steam thus generated would cost $200,000, figured on its initial cost and amortization in twenty years.

Second Type by Labor

For lower temperatures Mr. Hodgson proposed his second type of boring consisting of two vertical shafts each five miles deep and connected by horizontal passages thirty miles long. At this depth rock temperatures of between 400 and 450 deg. F. prevail. For the first thousand years such a bore would yield 4,500 hp.

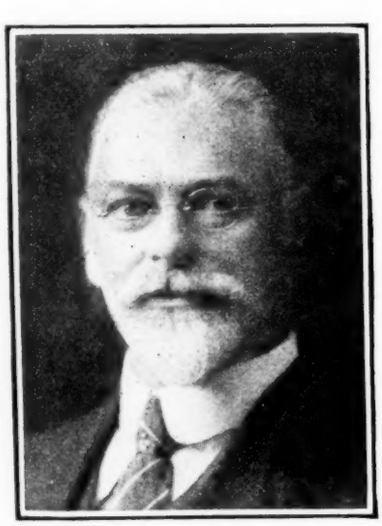
This theory expounded by Sir Charles Parson has met with severe criticism.

This second type of boring would be dug by laborers wearing heat-proof suits into which dry, cold air would be pumped from liquid air containers.

According to Mr. Hodgson, tapping the earth's heat would make possible "warming of soils to increase the crop yield and production of power for pumping water for irrigation or for manufacturing."

Albert A. Cary, Consulting Mechanical Engineer, Dies

Following several months of illness, Albert A. Cary, of New York City, consulting engineer for many years,



Albert A. Cary

and one of the early members of American Society of Mechanical Engineers, died Sept. 6 at his residence 325 West 93d Street.

Joined A.S.M.E. in '89

Mr. Cary was born in 1859. After attending a preparatory academy, he entered Worcester Polytechnic, and upon graduation he began his mechanical engineering career with an apprenticeship in the Cary Spring Works, New York City, in the late 70's. Following that association, Mr. Cary was connected with the firm of Abendroth & Root, manufacturers of boilers, Cliff Street. For the last 35 years he has been active in consulting capacity, with offices at 95 Liberty St., New York City. Boiler testing and plant investigations were his specialties.

Mr. Cary became a member of the American Society of Mechanical Engineers in 1889 and was a regular attendant at all local and annual meetings.

Honors Opening of Edison's Pearl Street Plant

Commemorating the opening of the Pearl Street plant of the New York Edison Co., forty-five years ago, Dr. John William Lieb, vice-president and general manager of the company, placed a wreath on the tablet marking the site in Pearl Street, New York, Sept. 3. Men who were associated with Mr. Edison in the industry's early days were present.

Dr. Lieb worked with the inventor in designing and building the station at 267 Pearl St., where began the industry which is capitalized in this country at nearly $20,000,000,000 and employs more than 1,000,000 persons.

At 3 p.m., Sept. 4, 1882, Mr. Edison turned the switch putting the plant in operation. He had on a white high-crowned derby and collarless shirt, having discarded collar and tie and a long frock coat so that he might work. The plant ran fourteen months without interruption, during which time the number of lights on the circuit increased from 5,500 to 12,732. There were 508 customers.

Edison labored untiringly, according to Dr. Lieb, working with the laborers building the station and installing equipment. He had invented the incandescent lamp and the electrical generator which supplies the current, perfected a system of wiring by which one lamp could be turned out without affecting the others, and built necessary switching mechanisms and the electric meter.

"Recalling Those Days"

Recalling those days, Mr. Edison once said: "When we put down the tubes in the lower part of New York, in the streets, we kept a big stock of them in the cellar of the station at Pearl Street. As I was on duty all the time I would take a nap of an hour or so in the daytime—anytime—and I used to sleep on those tubes in the cellar. Two men were testing there and both died of diphtheria caught in the cellar, which was cold and damp. It never affected me."

Investigating Flathead River

Members of the committee for allocation of waters of the Columbia River basin are in Kalispell, Mont., to investigate the possibilities of storage of the waters of the south fork of the Flathead River.

Included in the engineering group are State Engineer Heidel, of Montana; C. E. Carter, of Idaho; R. K. Tiffany, of Washington; G. L. Parker, of the United States Geological Survey, and O. L. Waller, engineering department of the Washington State College.

Dallas Installs Refrigerating Pipe Line System

An important phase in the refrigeration development of Dallas, Tex., was inaugurated Sept. 3, by the granting of an exclusive twenty-year franchise to F. O. Stevenson for the installation and maintenance of a refrigerating pipe-line system, using liquid ammonia as a refrigerant.

Under the terms of the franchise construction and operation of the plant are guaranteed within twelve months, and the construction of other units and extensions as directed by the city commission each year following.

Construction costs of the first unit and the laying of one mile of main lines and many laterals in the business district to supply refrigeration to restaurants, hotels and clubs, will total more than $500,000, it is reported. According to plan the lines will be extended into the residential districts for service in the home.

City Controlling Rates, Gets 4 Per Cent Plus Taxes

It is stated that the charge for the refrigerant will be $6.25 a ton delivered to meters at the door of the consumer's premises. By a ton of refrigerant, the franchise points out, is meant the amount of refrigerant necessary to convert one ton of water at 32 deg. F. into ice at the same temperature. The rate-making features of the franchise, however, will be in the hands of the city supervisor of public utilities, and the city will receive 4 per cent of the gross returns in addition to regular taxes.

Arizona Edison Plans Gila River Development

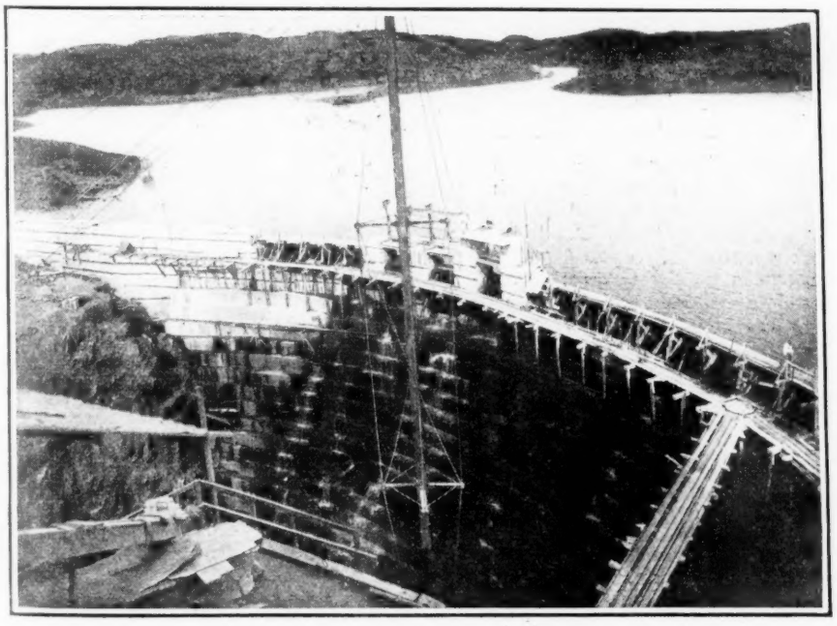
The Arizona Edison Co., of Douglas, Ariz., has applied to the Federal Power Commission for a preliminary permit covering a project on the Gila River in Graham and Greenlee Counties. It is proposed to erect a dam 260 ft. high and 1,700 ft. long. It is estimated that 19,000 hp. can be made available.

The application cannot be considered at this time because of the act of March 4, suspending consideration of any applications in the Colorado River Basin.

Reports on Savannah River Power Application

The chief of engineers has reported to the Federal Power Commission on the application of the Savannah River Power Co. for a license covering the Clarke Hill site on the Savannah River It is proposed to develop 35,000 hp. of primary power, but 120,000 hp. will be installed.

It is understood that the report recommends the issuance of the license with the ordinary conditions providing for the protection of navigation.



Unfinished Rio das Pedras Dam, Which Is Eighty Feet in Height and Five Hundred Feet in Length

An important and unusual hydro-electric development is being pushed to completion in Sao Paulo, Brazil. At the foot of the Serra do Mar, between Sao Paulo and Santos, the Sao Paulo Tramway, Light & Power Co., Ltd., has recently constructed a power plant, through the utilization of water from rivers flowing westward from the Serra, which have been dammed and their flow turned back across the watershed at Cubatao where an effective head of 2,200 ft. is available. The above view is of the dam made to create a reservoir for the penstocks.

Paul Hecht, Westinghouse M. E., Wins Promotion

The appointment of Paul Hecht, mechanical engineer of the South Philadelphia Works of the Westinghouse Electric & Manufacturing Co., as assistant to the vice-president, has just been announced by H. T. Herr, vice-president of the company.

Mr. Hecht was first employed by the Westinghouse Machine Co. in 1905, his

Paul Hecht

activities being assigned to the production department. In 1906 he was transferred to the contract manager's department, and in 1907 to the sales department, where he remained until 1914, when he joined the Export Co. now the Westinghouse International Co. In that capacity he headed up sales negotiations of machine works apparatus.

In 1916 he became employed in the department of price and estimating, and in 1920 moved to the South Philadelphia Works for similar duties. He carried on this work, besides many special services, until his recent appointment.

During twenty-two years of service Mr. Hecht has traveled widely in Germany, Great Britain and Belgium. He was the executive in charge under the vice-president of erecting the new turbine blade shop and the transferring of the blading activities from East Pittsburgh to South Philadelphia. He is a member of the American Management Association, the Philadelphia Chamber of Commerce and the American Society of Mechanical Engineers.

New England Water Works Association To Meet

For the first time in several years Boston is to be the scene of the annual convention—the 46th—of the New England Water Works Association. The Hotel Statler has been chosen as convention headquarters.

The preliminary program shows an imposing array of papers to be presented during the sessions—Sept. 13-16.

New Unit In Operation for West Texas Utilities

Operation of the first unit of 8,000 hp. in the new steam-driven electric plant of the West Texas Utilities Co. at San Angelo, Texas, has begun. The plant is designed to have ultimate capacity of 30,000 horsepower.

Other units will be installed as soon as the demand for power in the territory contiguous to San Angelo shall be developed, and this indicates that construction will not be long delayed on additional units, as power for the oil field communities of the Pecos River region is being supplied largely from this plant, and the oil field demand is rapidly growing.

The San Angelo plant is said to be one of the most modern in the Southwest. The building is designed to permit the addition of other units upon foundations already in place. The plant is located on the site of the old one, on the banks of the Concho River.

Testing Materials Congress Meets at Amsterdam

The International Congress for Testing Materials at Amsterdam, Holland, Sept. 12 to Sept. 17, will enjoy the co-operation on the subject of testing materials of experts of many nations.

At the general meetings of the Congress such prominent authorities will present papers, including T. D. Lynch, East Pittsburgh, Pa., "Materials Testing as a Stimulus to Research"; A. Mesnager, Paris, "La Rupture des Solides"; Professor Korber, Dusseldorf, "Das Problem der Streckgronze," and Doctor Rosenhain, England, "Plastic Deformation and Fracture of Metals."

The subjects to be treated at the Congress are divided in three sections, covering problems of metals, cement, concrete, stone and bricks and oils, rubber, wood, etc.

International Paper Leads

The International Paper Co. is now apparently the largest stockholder in the New England Power Association, which is part of the Buffalo-Boston superpower system, according to figures circulated in Wall Street. The F. L. Carlisle-Northeastern Power Corporation interests hold second place.

Switzerland Using More Water Power

Plans for thirteen new water-power plants, with an aggregate capacity of 964,000 hp. have been approved by the Swiss government, and construction work has already been begun. There are now 52 plants in the country with a capacity of over 10,000 hp., and 27 with over 20,000 hp. The first place is taken by the Vernayaz plant of the Federal Railways in the Rhone Valley, which is of 115,600 hp.

While the total water-power of Switzerland is estimated at some 4,000,000 hp., so far little more than one-half of it has been utilized, the total at the end of last year being but 2,241,000 hp.

Analysis of Distribution

At that time there were some 6,900 hydraulic power plants in the country. Five large new ones were completed during the year, four others were enlarged, and seven were under construction, 374,000 hp. being added.

Of the total capacity of 2,241,000 hp., private undertakings are utilizing 46 per cent, public undertakings 43 per cent and the Federal Railways 11 per cent. The Swiss hydro-electric plants yielded 3,465,000,000 kw.-hr. in 1924 and 3,702,000,000 in 1925 (the 1926 figures are as yet unavailable, but it is known that they will be higher). Of the power produced in 1925, 2,127,000,000 kw.-hr. was used for lighting, heating and motive power, 320,000,000 for tractive power, and 600,000,000 by the electro-metallurgical and chemical industry.

Arc Welded Roof Trusses, by H. H. Morse, published by the Linde Air Products Company. 17 pages, 8x11; bound in paper.

This publication consists of a report of the design, development, fabrication and testing of a series of oxy-acetylene welded roof trusses of the Fink type. It is well illustrated and contains a large amount of the detailed calculations involved in the design of trusses tested. It should be of great interest to consulting and designing engineers engaged in structural and welding work.

Obituary

Frank Forrester Thompson, professor of electrical engineering at Rutgers University, died from a fall while a guest at the Hotel Coleman, Lewistown, Pa., Sept. 4. Professor Thompson was 57 years of age, and a graduate of Princeton University of the class of 1894. He was instructor of physics at Union College, Schenectady from 1897 to 1898, and instructor of electrical engineering at Pennsylvania State College from 1898 to 1901. From 1903 to 1906 he served as instructor of electrical science at Rutgers and as assistant professor of physics from 1906 to 1908. Since 1908 he had been professor for electrical engineering.

Personal Mention

R. L. Wilson, works manager of the East Pittsburgh Works of the Westinghouse Electric & Manufacturing Co., becomes assistant to vice-president and general manager. Mr. Wilson has been active in electrical engineering since joining Westinghouse in 1893.

J. M. Hipple, manager of the motor engineering department of the Westinghouse Electric & Manufacturing Co., has been promoted to the position of works manager.

P. G. Welford has joined the Hamilton Gear & Machine Co., Toronto, Ont., in the capacity of sales engineer.

H. P. Cooper, mechanical engineer, is now on the engineering staff of the Texas Power & Light Co., Dallas, Texas.

Porter Hurd has left the employ of the Niagara Ammonia Co., Niagara Falls, N. Y., and is associated with the Surface Combustion Co., New York City.

J. H. Owsley, mechanical engineer, of Seattle, has completed a survey for a power line that will connect the town of Morton with Tacoma's hydro-electric plant and provide a light and power system for Morton.

Amory R. Haynes, formerly chief operator at the White River generating station of the Puget Sound Power & Light Co., Dieringer, Wash., has become electrical engineer of the light division of the Department of Public Utilities, City of Tacoma, Wash.

W. Clark, assistant engineer of the Hydro-Electric Power Commission, who has been in charge of the survey of Canadian power sites, recently returned from a short trip to this country, and is now engaged in investigating the power resources of the Montreal River.

Wilbur H. Judy, formerly chief engineer for Bearium Bearings, Inc., is now in Buenos Aires, Argentina. Mr. Judy expects to remain in South America for several years while engaged on several industrial engineering enterprises. He may be reached at 1887 Pedro Mendoza, Buenos Aires, Argentina.

C. P. Couch has been made vice-president and general manager of the Southern Ice & Utilities Co., according to announcements. Mr. Couch will make his headquarters in Dallas, Texas. Southern Ice & Utilities Co., whose general offices are at 520 Santa Fe Building, operates ice, ice cream, creamery and cold storage plants in some forty cities and towns of Texas, Oklahoma, Arkansas and Louisiana.

Society Affairs

The Boston Section, American Institute of Electrical Engineers, will hold its first fall meeting with an inspection trip to the airplane carrier "Lexington" at the Fore River Yard of the Bethlehem Shipbuilding Corp., Oct. 1.

The Massachusetts Chapter of the American Society of Heating and Ventilating Engineers will have the initial meeting of the season on

Monday, Oct. 3, and the regular monthly meetings on the first Monday of each month hereafter.

THE BOSTON SECTION, AMERICAN WELDING SOCIETY, will probably hold its first meeting of the season on the last Friday of September at the rooms of the Affiliated Technical Societies of Boston, 715 Tremont Temple. Details concerning this meeting are not yet available, but a later notice will be sent to the members.

Business Notes

THE MCGRAW-HILL PUBLISHING CO. announces the removal of its Washington office, in the charge of Paul Wooton, from the Colorado Building to 1252 B, C, D, National Press Building.

THE WADE ENGINEERING CO., Los Angeles, Calif., handling products of the Lincoln Electric Co., Cleveland, Ohio, announces that the northern office has been removed from 69 Webster St., Oakland, to 533-539 Market St., San Francisco.

THE FOOTE BROS. GEAR & MACHINE CO., Chicago, has announced that H. V. Greenwood, formerly sales manager, of the Baldwin Chain Co., recently joined the sales organization of the company as Michigan district representative. Mr. Greenwood makes his headquarters in Chicago, but covers the State of Michigan with the exception of the Detroit and Grand Rapids territory.

THE TRICO FUSE MANUFACTURING CO., Milwaukee, announces an improvement in its ferrule type renewable fuses. The improvement reduces the time spent in renewing fuses and eliminates all small loose parts. This is accomplished by a method of using spring retainers on the end caps to hold the end screws. There are now only two parts and the renewal element. The general design of the fuse requires the removal of only one cap when renewing.

Trade Catalogs

WATER CONTROLLING APPARATUS—A 123-page catalog on water-controlling apparatus has been issued by the Rodney Hunt Machine Co., Orange, Mass. In the first section of this catalog engineering data are given on problems in hydraulics, such as discharge of gates and sluices, flow of water through pipes, etc. This material has been presented in a manner to assist both engineers and laymen in selecting valves, gates and controlling devices. The equipment described comprises timber and metal gates, gate hoists and floor stands for the control of valves and gates.

GEARED TURBINE GENERATOR UNITS.—"Geared Turbine Generator Units 75 to 500 kw. for A.C. and D.C. Operation" is the subject of a new and attractive leaflet, No. 20,293, recently issued by the South Philadelphia Works of the Westinghouse Electric & Manufacturing Co. A number of photographs, showing the construction of these units, are included.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Refractories Institute will hold its fall meeting Thursday, Sept. 15, at the Clifton Hotel, Niagara Falls, Canada.

American Society of Heating & Ventilating Engineers, hold general meeting in New York City, during 4th week in January; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Refrigerating Engineers, annual convention in New York, Dec. 5-7; W. H. Ross, sec., 37 W. 39th St., New York City.

American Water Works Association. California Section, at San Jose, Oct. 5-8; Paul E. Magerstadt, sec., East Bay Water Co., Oakland; Central States Section will hold annual meeting at Akron, Ohio, Sept. 15-16; E. E. Bankson, sec., Union Bank Building, Pittsburgh. North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Southwest Waterworks Association will meet at Hot Springs, Ark., Oct. 10; Lewis A. Quigley, sec., superintendent of City Waterworks, Fort Worth, Tex. Iowa Section, at Council Bluffs, Hotel Chieftain, Sept. 28-30; Jack J. Hinman, Jr., secretary, P.O. Box 313, Iowa City.

American Socity of Mechanical Engineers, convention during week of New York Power Show, New York City, Dec. 5-10; Calvin Rice, sec., 29 West 39th St., New York City.

American Welding Society, fall meeting at Book Cadillac Hotel, Detroit, Sept. 19-23.

Association of Edison Illuminating Co's, convention at Colorado Springs, Col.; Sept. 26-30.

Empire State Gas and Electric Association, meeting at Lake Placid, N. Y.; Oct. 6-7.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National District Heating Association, annual meeting in May; D. L. Gaskill, sec. 112 West 4th St., Greenville, Ohio.

National Fuels Meeting, under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held Oct. 10-13 at St. Louis, Mo.

New York Power Show (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 5-10. Address inquiries to the International Exposition Co., Grand Central Palace.

Stoker Manufacturers Association, fall meeting at Buckwood Inn, Shawnee-on-Delaware, Pa., Sept. 26-28.

LINK BELT CONVEYOR DATA BOOK, No. 615—This is a combined general catalog and practical textbook on belt-conveyor drives and should find a welcome place in the library of the engineer who has to design installations of this kind. Numerous diagrams of typical belt-conveyor installations and methods of driving are presented. A chapter on engineering suggestions is also included, which embraces a chart of vertical, horizontal and inclined distances, tables of data for the selection of the width and speed of belts for various capacities, horsepower required to drive, and a number of typical problems in belt-conveyor designs.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Sept. 7 1927
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.61
Clearfield	Boston	1.60@ 1.90
Somerset	Boston	1.70@ 2.00
Kanawha	Columbus	1.75@ 2.00
Hocking	Columbus	2.00@ 2.25
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.35@ 1.60
Franklin, Ill.	Chicago	
Central, Ill.	Chicago	
Ind. 4th Vein	Chicago	
West Ky.	Louisville	2.00@ 2.50
S. E. Ky.	Louisville	1.40@ 1.75
Big Seam	Birmingham	1.60@ 2.00

*Gross tons f. o. b. vessel, Hampton Roads.

Anthracite (Gross Tons)		
Buckwheat No. 1.	New York	3.00@ 3.75
Buckwheat No. 1.	Philadelphia	3.00@ 3.75
Birdseye	New York	1.50@ 1.75

FUEL OIL

New York—Sept. 8, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

St. Louis — Aug. 24, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.625 per bbl.; 26@28 deg., $1.675 per bbl.; 28@30 deg., $1.725 per bbl.; 30@32 deg., $1.775 per bbl.; 32@36 deg., gas oil 4.35c. per gal.; 38@40 deg., 4.98c. per gal.

Pittsburgh—Aug. 30, f.o.b. local refinery; 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

Philadelphia—Sept. 1, 26@30 deg., $2@$2.06 per bbl.; 13@19 deg., $1.68@ $1.74 per bbl.; 22 plus, $1.79@$1.85; 27@30, $2.10@$2.16.

Cincinnati — Sept. 5, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

Chicago—Sept. 3, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 24@26 deg., 95c. per bbl.; 26@30 deg., 97½@$1.00; 30@32 deg., $1.05.

Boston—Sept. 6, tank-car lots, f.o.b. 12@14 deg. Baumé, 4½c. per gal; 28@32 deg., 5.8c. per gal.

Dallas—Sept. 3, f.o.b. local refiners, 26@30 deg., $1.45 per bbl.

NEW PLANT CONSTRUCTION

Calif., Los Angeles—Central Investment Co., Grand Ave., awarded contract for the construction of a 12 story addition to Biltmore hotel to Scofield Engineering Construction Co., 1100 Pacific Finance Bldg. Estimated cost $2,250,000. Steam heating system, elevators, etc. will be installed.

Calif., San Francisco—City plans an election to vote $1,800,000 bonds for a transmission line and step-down station to bring Moccasin Creek-Hetch Hetchy power from Newark to San Francisco. M. M. O'Shaughnessy, is city engineer.

D. C., Washington—Bureau of Standards, Dept. of Commerce, will receive bids until Sept. 20 for the construction of a power plant near Connecticut Ave. and Van Ness St. Estimated cost $185,000.

Ill., Chicago—Russell Plans Corp., 450 East Ohio St., is having plans prepared for the construction of a 16 story apartment including refrigeration and ventilation systems, elevators, etc. at 5421 Cornell Ave. W. Reichert & S. Finck, 35 South Dearborn St., are architects.

Ia., Sioux City—Sioux City Gas & Electric Co., awarded contract for the construction of a service building to W. A. Klinger Inc., 508 Warnock Bldg. Estimated cost $300,000.

Mass., Beverly — Commonwealth of Massachusetts, South Essex Sewage Dist., Salem, awarded contract for a pumping station, inlet, and sewers to Engineering Service & Construction Co., 220 Devonshire St., Boston. Estimated cost $27,298.

Mass., Brighton (Boston P.O.)—Boston Ice Co., 110 State St., Boston, awarded contract for the construction of an ice manufacturing plant at North Beacon and Hichborn Sts. to Scully Co., 238 Main St., Cambridge. Estimated cost $40,000.

Mass., Brockton—Edison Electric Illuminating Co., A. F. Nelson, Mgr., 42 Main St., will build a transformer station on Ames St. Private plans. Work will be done by separate contracts.

Mass., Dorchester (Boston P.O.)—Joseph Pollak Tool & Stamping Co., 81 Freeport St., awarded contract for addition to plant including a boiler room, to C. C. Temple Co., 99 Chauncy St., Boston.

Mass., North Attleboro—Elm Amusement Co., J. Levenson, Pres., 27 School St., Boston, is having plans prepared for remodeling heating plant of Elm Theatre, Washington St. Estimated cost $35,000. Funk & Wilcox, 25 Pemberton Sq., Boston, are architects and engineers.

Mass., Taunton — Commonwealth of Massachusetts, Dept. of Mental Diseases, will soon award contract for a refrigeration plant at State Hospital. Estimated cost $25,000. Private plans.

Minn., Cloquet — Northwest Paper Co. awarded contract for addition to power plant. Estimated cost $100,000.

Minn., Minneapolis — Minneapolis Mfg. Co., East Hennepin and 5th Aves. S. E., awarded contract for the construction of a power plant to Arnold Construction Co., 510 Guardian Life Bldg., St. Paul. Estimated cost $60,000.

Mo., St. Louis—Terminal Railroad Association, 1800 Market St., awarded contract for the construction of a 46 x 70 ft. power plant at 3251 Scott Ave. to Parker Russell Mining & Mfg. Co., 3314 Morganford Rd.

N. H., Epping—Bd. of Selectmen, is receiving bids for a waterworks system including power house, etc. Estimated cost $30,000. Private plans.

N. J., Camden—Camden Rail & Harbor Corp., c/o Fred Cohen, Merchantville, is having plans prepared for the construction of a cold storage plant on Kaighn Ave. here. Estimated cost $2,225,000. Architect not announced.

N. Y., Albany—Dept. of Health, Capitol, will receive bids until Sept. 29, for the construction of a power house, etc.

N. Y., Brooklyn—Dept. of Public Welfare, T. S. Coler, Comr. Municipal Bldg., New York, will soon award contract for addition to hospital, nurses' home, power house, etc. at Coney Island Hospital, Ocean Parkway here.

N. Y., Raybrook—Dept. of Standards and Purchase, Capitol, Albany, will soon award contract for the construction of a power house for State Hospital for the Treatment of Incipient Pulmonary Tuberculosis here.

With this issue, *Power* resumes its former and usual method of publishing the names and addresses of the responsible parties in charge of the projects listed on this page.

A. W. WELCH
Power Information Bureau
Tenth Ave. at 36th St.
New York, N. Y.

N. C., Greenville—Bd. of Trustees of East Carolina Teachers College, E. G. Flanagan, Chn., will receive bids until Sept. 29 for the construction of first unit to training school including new power house, addition to central power plant and cold storage plant, etc.

N. D., Mandan—Northern Pacific Ry., St. Paul, Minn., awarded contract for the construction of a 40 x 80 ft. power plant. Estimated cost $100,000. H. E. Stevens, St. Paul, Minn., is chief engineer.

Okla., Hobart—City is having preliminary plans prepared for waterworks improvements including pumping unit, mains, etc. Estimated cost $65,000.

Texas — Southern Gas & Utilities Co., Frost National Bank Bldg., San Antonio, awarded contract for the construction of a natural gas distributing system including booster stations and pumping plants at New Braunfels, Seguin, San Antonio and San Marcos, to N. A. Saigh & Co., 411 Builders Exchange Bldg., San Antonio. Estimated cost $100,000, $50,000, $650,000 and $40,000 respectively.

Tex., Bryan—Brazos River Reclamation Assn., c/o J. M. Lawrence, Pres., is having plans prepared for the construction of four hydro-electric plants and twelve reservoirs on the Brazos River. Estimated cost approximately $50,000,000. Engineer not announced.

Tex., Dallas—Stevenson Engineering Co., c/o F. O. Stevenson, Pres., Fort Worth National Bank Bldg., Fort Worth, plans the construction of a liquid and ammonia refrigeration plant, 1,000 ton daily capacity. Estimated cost $1,000,000.

Tex., Galveston—T. A. Hunter, 1127 A. St., is having preliminary plans prepared for the construction of a 50 ton ice plant. Estimated cost $75,000. Private plans.

Tex., McCamey—Pecos Valley Power & Light Co., has been granted permit for the construction of a pumping plant to divert 4,000 acre ft. of water from the Pecos River for power generation. Estimated cost $100,000. Private plans.

Tex., Plemons—Phillips Petroleum Co., Bartlesville, Okla., has been granted permit for the construction of a pumping plant on Big Creek to divert 471 acre ft. of water. Estimated cost $75,000. Machinery will be required.

Tex., Rotan—City is having preliminary plans prepared for waterworks improvements including reservoir, pumping unit, etc. Estimated cost $150,000.

Tex., San Antonio—Texas Pecan Shelling Co., E. M. Zerr, 426 South Laredo St., is having preliminary plans prepared for the construction of a pecan shelling plant including cold storage warehouse, etc. at Salado, Monterey and Comal Sts. here. Estimated cost $450,000.

Tex., Waskom — Dixie Pipe Line Co., Shreveport, La., awarded contract for the construction of a pumping station near here, to Hope Engineering & Supply Co., Mt. Vernon, O. Estimated cost including machinery $650,000.

Ont., London—Utilities Comn., awarded contract for waterworks improvements including drilling test wells, installing pumps, etc. to increase supply 1,000,000 g.p.d. to Layne & Bowler Chicago Co., 37 West Van Buren St., Chicago, Ill. Estimated cost $40,000.

Ont., Ottawa—Canadian National Railways, Montreal, Que., will receive bids until Sept. 15 for extension to the Chateau Laurier hotel on Rideau St. here. Estimated cost $1,500,000. J. S. Archibald, 1134 Beaver Hall Hill, Montreal, Que., Archt.

T. H., Pearl Harbor—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will soon receive bids for the construction of a boiler house, etc. at Naval Operating Base (Submarine Base) here.

Equipment Wanted

Air Compressor—J. D. Bartlett, Mgr., Amarillo, Tex., in the market for an air compressor, etc. for proposed waterworks improvements at Lake Amarillo.

Boiler House Stack and Heating System—Constructing Quartermaster, Washington, D. C., will receive bids until Sept. 14, for a boiler house stack and heating system at Bolling Field.

Coal and Ash Handling Equipment—Bd. of Public Service, 208 City Hall, St. Louis, Mo., will receive bids until Oct. 4 for coal and ash handling equipment for municipal service building at 12th St. and Clark Ave. Estimated cost $30,000.

Drum Hoister—J. A. Heissler, Sayville, N. Y., is in the market for a triple drum hoister with 35 to 50 hp. gasoline engine.

Engines and Generators—V. M. Sprengel, Comr. of Utilities, Wagoner, Okla., in the market for two 300 hp. Diesel engines and generators for electric light plant.

Motor, Reduction Gear Vacuum System, Etc.—Bd. of Trustees of Des Moines County Drainage Dist., No. 7., Burlington, Ia., will receive bids until Sept. 20 for electrifying one unit of Lazwell pumping station consisting of 400 hp. slip ring motor, reduction gear unit vacuum system, etc.

Power House Equipment—S. A. Stromme, Clk., Lanesboro, Minn., will receive bids until Sept. 22, for power house equipment including a 300 to 400 hp. full Diesel engine and generator, etc.

Pump, Motor, etc. — Commissioners of Oxford, Md., will receive bids until Sept. 21, for furnishing and installing a pump, motor and appurtenances, for proposed pumping station.

Pump and Motor—City of Southgate, Calif., is receiving new bids for furnishing and installing deep well pump, and electric motor, etc. Former bids rejected.

Pumping Equipment—City of Marion, Ill., will soon receive bids for pumping equipment, etc. for proposed sewage disposal plant. Estimated cost $83,207.

Pumping Equipment, Etc.—City of Cordell, Okla., will be in the market for pumping equipment, etc. for proposed waterworks system. Estimated cost $26,500.

Pumping Equipment—E. L. Vegely, Santa Ana, Calif., will receive bids until Sept. 19 for furnishing and installing pumping equipment for proposed sewage screening building.

Pumping Equipment—City of Rio Hondo, Tex., will be in the market for pumping equipment, for proposed waterworks improvements. Estimated cost $15,000.

Pumping Unit—Bd. of Water Comrs., A. Dow, Pres., 176 East Jefferson Ave., Detroit, Mich., will receive bids until Oct. 5, for a 10,000 g.p.m. electric motor driven centrifugal pumping unit with auxiliary equipment.

Pumps, Etc.—City of Ryan, Okla., is receiving bids for pumps, etc. for proposed waterworks improvements. Estimated cost $15,000.

Pumps and Pumping Equipment—D. McCoy, Clk., Longton, Kan., will receive bids until Sept. 15, for pumps and pumping equipment, etc. for proposed waterworks improvements.

Refrigeration Equipment — Bureau of Yards & Docks, Navy Dept., Washington, D. C., is in the market for refrigeration equipment including motor driven compressors, motor driven brine pumps, etc. for refrigeration plant at Naval Operating Base (Submarine Base) Pearl Harbor, T. H.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

DEFINITE firmness is evident in quotations on non-ferrous power plant supplies; steel items, however, remain steady, with some weakness in cold drawn material at central points. Paint stuffs are in a stronger price position than a month ago. Electrical supplies appear featureless so far as price changes are concerned.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 68c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	50%

Air—Best grade

¾-in., per ft.	3-ply	$0.34	4 ply	$0.42

Steam—Discounts from List

First grade 40% Second grade 40–5% Third grade 50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40–5%
Heavy	30–10%

RAWHIDE LACING For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¼ in.	$0.95
Asbestos for high-pressure steam, ¼ in.	1.75
Duck and rubber for piston packing	.95
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.30
Rubber sheet	.50
Rubber sheet, wire insertion	.80
Rubber sheet, duck insertion	.60
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.35 per bbl. without bags, in carload lots delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00@20.00
Colored	9.00@13.00	12.00	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15
New York	.15½
Cleveland (*per thousand*)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.86¼	$0.91	$0.83½

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, 7/16-in., dia. and smaller, list (Apr. 1, 1927) less 50-10% in full keg lots. EXTRA per 100 lb. for ½-in. dia., 35c.; ⅜-in., 15c.; 1-in., 5c.; lengths, 1-in. and shorter, 25c.; longer than 1-in. up to and including 1 1/2-in., 15c.; longer than 5-in., 25c.; standard countersunk head, 25c.

Structural rivets, per 100 lb.:

New York $5.00* Chicago $3.60 Pittsburgh mill $2.75@$3.00

Cone-head boiler rivets, per 100 lb.:

New York $5.00* Chicago $3.60 Pittsburgh mill $3.10@$3.35

*Full keg lots.

REFRACTORIES—Prices in car-load lots, f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	26@29
Magnesite brick, 9-in. straights	net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	net ton	71.50
Magnesite brick, Soaps and splits	per ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	83.00
Commercial genuine, intermediate grade	61.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	13.00

COLD DRAWN STEEL—Warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Shafting and screw stock, round and hexagon	$4.00	$3.65	$3.60
Flats and squares	4.50	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following percentage discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Galv.	Inches	Iron Black	Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers.

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3½ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$30.00 (net)	$46.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft.	60%	30%
1,000 to 5,000 ft.	65%	35%
5,000 ft. and over	67%	38%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
½	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
¾	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$17.75
No. 16 cotton reinforced heavy		22.00
No. 18 cotton reinforced light		14.50
No. 16 cotton reinforced light		18.35
No. 18 cotton Canvasite cord		14.75
No. 16 cotton Canvasite cord		17.20
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$72.00	*80.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	110.00	*122.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 64%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than standard pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals.	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.75
0-30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt Watts	Type	Price Each	200—260 Volt Watts	Type	Price Each
			Special		
15	A 17	$0.23	25	A 19	$0.28
			50	A 21	.28
General			100	A 23	.50
25	A 19	.23			
40	A 21	.23			
50	A 21	.25			
60	A 21	.25			
100	A 23	.40			

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.80	$9.00	$10.80	$16.75
12	9.70	12.20	14.20	23.20
10	12.80	15.70	18.10	30.15
8	18.70	21.40	23.70	41.75
6	.....	.....	33.75	.....
4	.....	.....	47.00	.....
2	.....	.....	66.25	.....
1	.....	.....	91.00	.....
0	.....	.....	112.50	.....
00	.....	.....	133.00	.....
000	.....	.....	159.40	.....
0000	.....	.....	190.24	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package.	$0.17	$0.15	$0.22	$0.20	$0.18	$0.25
Unbroken carton..	.18	.16	.23	.22	.19	.26
Broken carton....	.20	.18	.25	.24	.21	.28

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb., 31c. lb.; 100 lb. lots	29c. lb.
Rubber tape, ¾ in., less 100 lb., 33c. lb.; 100 lb. lots	31c. lb.
Wire solder, less 100 lb., 33c. lb.; 100 lb. lots	31c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	30–5%
$50.00 list value or over	35%